UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

In response refer to:
2009/01912

AUG 18 2009

Francis C. Piccola
Chief, Planning Division
U.S. Army Engineer District, Sacramento
1325 J Street
Sacramento, California 95814-2922

Dear Mr. Piccola:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) biological and conference opinion (Enclosure 1) based on our review of the U.S. Army Corps of Engineers (Corps) proposed Steamboat Slough Public Law (PL) 84-99 Levee Repairs Project, and their effects on Federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), and their designated critical habitat in accordance with section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). This biological and conference opinion also includes a section 7(a)(2) analysis of project related effects on the threatened Southern distinct population segment (DPS) of North American green sturgeon (*Acipenser medirostris*) and their proposed critical habitat.

The proposed levee repairs are being performed pursuant to Governor Schwarzenegger's February 24, 2006, emergency proclamation for California's levee system. The Governor's proclamation ordered the emergency repair of levees to prevent the imminent loss of human property and life. The Governor later signed Executive Order S-18-06, directing the California Department of Water Resources to identify and repair eroded levee sites on the State/Federal levee system to prevent catastrophic flooding and loss of life. The 18 sites identified in the Steamboat Slough Levee Repair Project are eligible for PL 84-99 Rehabilitation Assistance and are part of the State of California's highest priority for emergency repairs.

This biological and conference opinion is based on information provided in the April 2009, *Steamboat Slough Levee Repair Project, Sacramento County, California Biological Assessment,* and the April 2009 *Evaluation of the Steamboat Slough PL 84-99 Emergency Repair Sites, using the Standard Assessment Method.* The biological and conference opinion also is based on design drawings, site visits and discussions held with representatives of NMFS, U.S. Fish and Wildlife Service, the California Department of Fish and Game, and the Corps. A complete administrative record of this consultation is on file at the NMFS Sacramento Field Office.

Based on the best available scientific and commercial information, the biological and conference opinion concludes that these projects are not likely to jeopardize the above species or adversely modify designated or proposed critical habitat. NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to minimize incidental take associated with project actions. The listing of the Southern DPS of North American green sturgeon became effective on July 7, 2006, and some or all of the ESA section 9(a)(1) prohibitions against take will become effective upon the future issuance of protective regulations under section 4(d). Because there are no section 9(a)(1) prohibitions at this time, the incidental take statement, as it pertains to the Southern DPS of North American green sturgeon does not become effective until the issuance of a final 4(d) regulation, as appropriate.

Also enclosed are EFH Conservation Recommendations for Pacific salmon as required by the MSA as amended (16 U.S.C. 1801 *et seq.;* Enclosure 2). This document concludes that the Steamboat Slough Emergency Levee Repair Project will adversely affect the EFH of Pacific Salmon in the action area and adopts certain of the terms and conditions of the incidental take statement and the ESA Conservation Recommendations of the biological and conference opinion as the EFH Conservation Recommendations.

Section 305(b)4(B) of the MSA requires that the Corps provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR 600.920[j]). In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

If you have any questions regarding this correspondence please contact Karen McCartney in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814. Karen McCartney may also be reached by telephone at (916) 930-3615 or by Fax at (916) 930-3629.

Sincerely,

for Rodney R. McInnis
Regional Administrator

Enclosures (2)

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Enclosure 1

BIOLOGICAL AND CONFERENCE OPINION

ACTION AGENCY: United States Army Corps of Engineers

ACTIVITY: Steamboat Slough Levee Repair Project

CONSULTATION
CONDUCTED BY: NOAA's National Marine Fisheries Service Southwest Region

TRACKING NUMBER: 2009/01912

DATE ISSUED: AUG 18 2009

I. CONSULTATION HISTORY

On February 24, 2006, Governor Arnold Schwarzenegger issued an emergency proclamation for California's levee system. The proclamation focused on the imminent threat of 24 critical levee erosion sites located in Colusa, Sacramento, Solano, Sutter, Yolo, and Yuba counties. As a result, 33 critical levee repairs were undertaken between July and November 2006.

On August 25, 2006, the U.S. Army Corps of Engineers (Corps) determined that PL 84-99 Order 1 and 2 sites present an imminent threat to public life and property and authorized immediate emergency levee repair actions.

On September 30, 2006, the California Department of Water Resources (CDWR) determined that the Governor's proclamation encompassed PL 84-99 Order 1 and 2 sites and provided State funding to implement their repairs.

On April 15, 2009, NOAA received a Biological Assessment for the Steamboat Slough Levee Repair Project and a request to initiate formal consultation.

A complete administrative record of this consultation is on file at the NMFS Sacramento Area Office.

II. DESCRIPTION OF THE PROPOSED ACTION

Between December 28, 2005 and January 9, 2006, the State of California experienced a series of severe storms which damaged many levees within the Corps Sacramento District's boundaries. Water levels increased again in April 2006 and high water remained in some parts of the system until June. Many rivers and streams within the Sacramento and San Joaquin River Basins ran above flood stage during these events, and there were significant erosion and seepage problems with some of the levees. CDWR and/or their maintaining agencies conducted flood fight activities while the Corps worked with the State to restore the levee systems to their pre-storm level of protection. These efforts have been conducted under the authority of PL 84-99, Rehabilitation of Damaged Flood Control Works.

High water stages produced heavy damage to the levee embankments. Some of the damages have reduced the stability of the levee below the acceptable limits and may result in potential breaches in the levee and flooding in protected areas. The damages that may contribute to breaches in the levee were considered Order 1 and 2 for repair, since the protected area includes a developed urban area. Other damages that do not reduce the levee stability below the acceptable limits, but may be exacerbated during the next flood season, are repaired later under PL 84-99 authority and are considered Order 3 and 4 for repair.

A. Construction Activities

1. Reclamation District 3

Construction activities are scheduled to begin on August 1, 2009 and would be completed by September 30th, 2009, although construction may occur as late as Oct 31, 2009, depending on contracting and other logistical planning. The site is a total of 420 feet long, consisting of 345 linear feet of out of water work and 75 linear feet of in water work. The area will be grubbed to a maximum depth of 5 feet. Six inches of bedding material will be placed into the cleared area. After the bedding material is placed, 24 inches of riprap with an average size of 9 inches, will be placed where needed by pushing into place from the crest. Four inch minus rock will be broadcast on top of riprap to fill in interstitial voids. Additionally, orange fencing will be placed at the new levee toe to protect all in water vegetation that consists mainly of horsetail (*Equisetum sp.*), and all IWM present will be marked for preservation.

Willow planting would be planted at the toe of the levee while hydroseeding will occur in the disturbed areas on the upper slope of the levee.

2. Reclamation District 150

Construction activities are scheduled to begin August 1, 2009 and would be completed by September 30th, 2009. Erosion damage exists at 17 sites along the Sacramento River within Reclamation District 150. Erosion sites consist of wave wash erosion, levee toe scours and loss of rock protection along an intermittent 7,033 linear feet of waterside levee slope. Repairs will excavate the eroded slope at least 6 inches beyond the damaged surface and backfill the area with quarry rock. The quarry rock will be covered by two feet of riprap with an average size of 9 inches placed on a 6 inch thick layer of bedding material. Surface voids in the rock will be filled by casting four inch minus rock on top of the riprap to fill in interstitial voids. To the extent possible all vegetation currently on site greater than 4 inches in diameter will be protected and left in place.

Willow (*Salix spp.*) will be planted along the toe of the waterside levee slope. Pole cuttings will be gathered from shrubs near the project area and planted 6 feet apart in two rows on a 2 foot off center pattern along the levee toe for the length of each repair site using the "Stinger" method. The "Stinger" is designed to be heavy enough to punch a hole down through the spaces between large rock riprap into moist to wet soil underneath. Once the "Stinger" reaches the soil under the rock riprap, it is pushed deep enough to make a hole that allows the placement of the willow cutting into permanently moist soil. No additional soil or irrigation will be provided for by the Corps.

B. Project Operation and Maintenance

Operation and Maintenance (O&M) activities that may be necessary for three to five years to maintain the flood control and environmental values at each site include removing invasive vegetation determined to be detrimental to the success of the project, replacing vegetation plantings to maintain a 50% survivability rate of all plantings for a period of three years, and placing fill and rock revetment if the site is damaged during high flow events or vandalism.

Maintenance of conservation measures will be conducted to the extent necessary to ensure that the overall long-term habitat effects of the project are positive, as determined by the Standard Assessment Methodology (SAM). The SAM quantifies habitat values in terms of bank line- or area-weighted species responses that are calculated by combining habitat quality (fish response indices) with quantity (bank length or wetted area) for each season, target year, and relevant species and life stage. The SAM employs six habitat variables to characterize near shore and floodplain habitats of listed fish species.

C. Monitoring

The Corps will, within 90 days of the completion of construction, submit a detailed, site-specific monitoring plan for NMFS to review. The Corps proposes to apply this plan to the critical erosion repair sites, and other sites, as necessary for approximately 5 years following construction. The monitoring plan will be incorporated into the O&M manual and implemented at all project sites. One element of the monitoring plan includes photographic documentation of the status and progress of the planted riparian vegetation.

Monitoring is necessary to ensure that the riparian vegetation planted is functioning as projected by the SAM model. The Corps shall submit a yearly report of monitoring results to the resource agencies by December 31 of each year. Monitoring is to be conducted until such time as the projected benefits of mitigation actions to Federally listed fish species can either be substantially confirmed or discounted. If integrated conservation measures fail to meet modeled SAM values, specific remedial measures for each type of conservation measure (i.e., riparian survival and growth) and the level of effort applied to implement such measures will be determined based on the magnitude and the causes of failure. Potential remedial measures may include: (1) planting additional vegetation at the project site, and/or (2) planting additional plants at offsite locations.

D. Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR § 402.02). The action area for the overall Steamboat Slough PL 84-99 extends south-to-north along the Sacramento River from the town of Courtland, at river mile (RM) 34 upstream to Clarksburg at (RM) 42, and includes one site near the confluence of the Sacramento River and Steamboat Slough near Courtland.

III. STATUS OF THE SPECIES/CRITICAL HABITAT

The following Federally listed species evolutionarily significant units (ESU) or distinct population segments (DPS) and designated or proposed critical habitat that occur in the action area and may be affected by the proposed project:

Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
Listed as endangered (June 28, 2005, 70 FR 37160)

Sacramento River winter-run Chinook salmon designated critical habitat
(June 16, 1993, 58 FR 33212)

Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*)
Listed as threatened (June 28, 2005, 70 FR 37160)

Central Valley spring-run Chinook salmon designated critical habitat
(September 2, 2005, 70 FR 52488)

Central Valley steelhead DPS (*O. mykiss*)
Listed as threatened (January 5, 2006, 71 FR 834)

Central Valley steelhead designated critical habitat
(September 2, 2005, 70 FR 52488)

Southern DPS of North American green sturgeon (*Acipenser medirostris*)
Listed as threatened (April 7, 2006, 70 FR 17386)

Southern DPS of North American green sturgeon proposed critical habitat
(September 8, 2008, 73 FR 52084)

A. Species Life History, Population Dynamics, and Likelihood of Survival

1. <u>Chinook salmon</u>

Chinook salmon are anadromous and the largest member of *Oncorhynchus*, with adults weighing more than 120 pounds having been reported from North American waters (Scott and Crossman 1973, Eschmeyer *et al.* 1983, Page and Burr 1991). Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). "Stream-type" Chinook salmon enter freshwater months before spawning and reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Spring-run Chinook salmon exhibit a stream-type life history. Adults enter freshwater in the spring, hold over the summer, spawn in the fall, and the juveniles typically spend a year or more in freshwater before emigrating. Winter-run Chinook salmon are somewhat anomalous in that they have characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in the winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only 4 to 7 months of river life (ocean-type). Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998). Freshwater entry and spawning timing are generally thought to be related to local water temperature and flow regimes. Runs are designated on the basis of adult migration timing. However, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

Information on the migration rates of adult Chinook salmon in freshwater is scant and primarily comes from the Columbia River basin, where information regarding migration behavior is needed to assess the effects of dams on travel times and passage (Matter and Sanford 2003). Keefer *et al.* (2004) found migration rates of Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin. Matter and Sanford (2003) documented migration rates of adult Chinook salmon ranging from 29 to 32 km per day in the Snake River. Adult Chinook salmon inserted with sonic tags and tracked throughout the Delta and lower Sacramento and San Joaquin rivers were observed exhibiting substantial upstream and downstream movement in a random fashion, several days at a time, while migrating upstream [California Bay-Delta Program (CALFED) 2001]. Adult salmonids migrating upstream are assumed to make greater use of pool and mid-channel habitat than channel margins (Stillwater Sciences 2004), particularly larger salmon such as Chinook salmon, as described by Hughes (2004). Adults are thought to exhibit crepuscular behavior during their upstream migrations, meaning that they are primarily active during twilight hours. Recent hydroacoustic monitoring conducted by LGL Environmental Research Associates showed peak upstream movement of adult Central Valley spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring in the 4-hour period before sunrise and again after sunset.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools [U.S. Fish and Wildlife Service (USFWS) 1995]. Upon emergence, fry swim or are displaced downstream (Healey 1991). Similar to adult movement, juvenile salmonid downstream movement is crepuscular.

Documents and data provided to NMFS in support of ESA section 10 research permit applications depict that the daily migration of juveniles passing RBDD is highest in the 4-hour period prior to sunrise (*e.g.*, Martin *et al.* 2001). Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in the stream for a period of time from weeks to a year (Healey 1991).

Fry then seek nearshore habitats containing riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (NMFS 1996). The benefits of shallow water habitats for salmonid rearing have been found to be more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001).

As juvenile Chinook salmon grow, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures (Healey 1991). Catches of juvenile salmon in the Sacramento River near West Sacramento exhibited larger-sized juveniles captured in the main channel and smaller-sized fry along the margins (USFWS 1997). When the river channel is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1980). Stream flow and/or turbidity increases in the upper Sacramento River basin are thought to stimulate emigration (Kjelson *et al.* 1982, Brandes and McLain 2001).

Juvenile Chinook salmon migration rates vary considerably, presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1982) found fry Chinook salmon to travel as fast as 30 km per day in the Sacramento River and Sommer *et al.* (2001) found rates ranging from approximately 0.5 miles up to more than 6 miles per day in the Yolo Bypass. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healey 1980, Levy and Northcote 1981). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally-influenced sandy beaches and vegetated zones (Meyer 1979, Healey 1980). Cladocerans, copepods, amphipods, and diptera larvae, as well as small arachnids and ants, are common prey items (Kjelson *et al.* 1982, MacFarlane and Norton 2001, Sommer *et al.* 2001).

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1981, Healey 1991). Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Juvenile Chinook salmon were found to spend about 40 days migrating through the Sacramento-San Joaquin Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallone Islands (MacFarlane and Norton 2001). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon), MacFarlane and Norton (2001) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

a. Status of Sacramento River Winter-Run Chinook Salmon

Sacramento River winter-run Chinook salmon were originally listed as threatened in August 1989, under emergency provisions of the ESA, and formally listed as threatened in November 1990 (55 FR 46515). The ESU was reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. NMFS reaffirmed the listing of Sacramento River winter-run Chinook salmon as endangered on June 28, 2005 (70 FR 37160). The ESU consists of only one population that is confined to the upper Sacramento River in California's Central Valley. The Livingston Stone National Fish Hatchery population has been included in the listed Sacramento River winter-run Chinook salmon ESU (June 28, 2005, 70 FR 37160). NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212).

Sacramento River winter-run Chinook salmon adults enter the Sacramento River basin between December and July, the peak occurring in March (table 1; Yoshiyama *et al.* 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick Dam and RBDD (Vogel and Marine 1991). The majority of Sacramento River winter-run Chinook salmon spawners are 3 years old.

Emigration of juvenile Sacramento River winter-run Chinook salmon past RBDD may begin as early as mid July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991). From 1995 to 1999, all Sacramento River winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Juvenile Sacramento River winter-run Chinook salmon occur in the Delta primarily from November through early May, based on data collected from trawls in the Sacramento River at West Sacramento [river mile (RM) 57, USFWS 2001]. The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Winter-run Chinook salmon juveniles remain in the Delta until they reach a fork length of approximately 118 millimeters (mm) and are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continuing through May (Fisher 1994, Myers *et al.* 1998).

Historical Sacramento River winter-run Chinook salmon population estimates were as high as near 100,000 fish in the 1960s, but declined to under 200 fish in the 1990s (Good *et al.* 2005). In recent years, the carcass survey population estimates of winter-run Chinook salmon included 8,218 in 2003, 7,869 in 2004, 15,839 in 2005, 17,334 in 2006 (CDFG 2008) which show a recent increase in the population size and a 4-year average of 12,315. The 2006 run was the highest since the listing. However, the population estimate for winter-run Chinook salmon in 2007 was only 2,542, and the preliminary population estimate was only 2,850 in 2008 (CDFG 2008). The ocean life history traits and habitat requirements of winter-run Chinook salmon and fall-run Chinook salmon are similar. Therefore, the unusual and poor ocean conditions that contributed to the drastic decline in returning fall run Chinook salmon populations coast wide in 2007 and 2008 (Varanasi and Bartoo 2008) are suspected to have also caused the observed decrease in the winter-run Chinook salmon spawning population in these years (Oppenheim 2008). Two current methods are utilized to estimate the juvenile production of Sacramento River winter-run Chinook salmon: the Juvenile Production Estimate (JPE) method, and the Juvenile Production Index (JPI) method (Gaines and Poytress 2004). Gaines and Poytress (2004) estimated the juvenile population of Sacramento River winter-run Chinook salmon exiting the upper Sacramento River at RBDD to be 3,707,916 juveniles per year using the JPI method between the years 1995 and 2003 (excluding 2000 and 2001). Using the JPE method, Gaines and Poytress (2004) estimated an average of 3,857,036 juveniles exiting in the upper Sacramento River at RBDD between the years of 1996 and 2003. Averaging these 2 estimates yields an estimated population size of 3,782,476 juveniles during that time frame.

Based on RBDD counts, the population has been growing rapidly since the 1990s with positive short-term trends. An age-structured density-independent model of spawning escapement by Botsford and Brittnacher (1998) assessing the viability of Sacramento River winter-run Chinook salmon found the species was certain to fall below the quasi-extinction threshold of 3 consecutive spawning runs with fewer than 50 females (Good *et al.* 2005). Lindley and Mohr (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures. They found a biologically significant expected quasi-extinction probability of 28 percent. There is only one population of Sacramento River winter-run Chinook salmon, which depends on cold-water releases from Shasta Dam, and could be vulnerable to a prolonged drought (Good *et al.* 2005).

Lindley *et al.* (2007), in their framework for assessing the viability of Chinook salmon and steelhead in the Sacramento-San Joaquin River basin, concluded that the population of winter-run Chinook salmon that spawns below Keswick Dam satisfies low-risk criteria for population size and population decline, but increasing hatchery influence is a concern that puts the population at a moderate risk of extinction. Furthermore, Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term.

b. Status of Central Valley Spring-Run Chinook Salmon

NMFS listed the Central Valley spring-run Chinook salmon ESU as threatened on September 16, 1999 (64 FR 50394). In June 2004, NMFS proposed that Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). This proposal was based on the recognition that although Central Valley spring-run Chinook salmon productivity trends are positive, the ESU continues to face risks from having a limited number of remaining populations (*i.e.*, 3 existing populations from an estimated 17 historical populations), a limited geographic distribution, and potential hybridization with Feather River Hatchery (FRH) spring-run Chinook salmon, which until recently were not included in the ESU and are genetically divergent from other populations in Mill, Deer, and Butte Creeks. On June 28, 2005 (70 FR 37160), after reviewing the best available scientific and commercial information, NMFS issued its final rule to retain the status of Central Valley spring-run Chinook salmon as threatened. This decision also included the FRH spring-run Chinook salmon population as part of the Central Valley spring-run Chinook salmon ESU. Critical habitat was designated for Central Valley spring-run Chinook salmon on September 2, 2005 (70 FR 52488).

Adult Central Valley spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (table 2, Yoshiyama *et al.* 1998, Moyle 2002). Lindley *et al.* (2006a) indicated that adult Central Valley spring-run Chinook salmon enter native tributaries from the Sacramento River primarily between mid April and mid June. Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering, while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

Table 1. The temporal occurrence of adult and juvenile Sacramento River winter-run Chinook salmon in the Sacramento River.

Adult Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin[1]												
Sacramento River[2]												
Juvenile Location	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Sacramento River at Red Bluff[3]												
Sacramento River at Red Bluff[2]												
Sacramento River at Knights Landing[4]												
Lower Sacramento River (seine)[5]												
West Sacramento River (trawl)[5]												

Relative Abundance: =High =Medium =Low

Sources: [1] Yoshiyama *et al.* (1998); Moyle (2002); [2] Meyers *et al.* (1998); [3] Martin *et al.* (2001); [4] Snider and Titus (2000); [5] USFWS (2001)

Table 2. The temporal occurrence of adult and juvenile Central Valley spring-run Chinook salmon in the Sacramento River.

Adult Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin[1,2]												
Sacramento River[3]												
Mill Creek[4]												
Deer Creek[4]												
Butte Creek[4]												
Juvenile Location	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Sacramento River Tributaries												
Upper Butte Creek												
Mill, Deer, Butte Creeks												
Sacramento River @ RBDD												
Sacramento River @ Knights Landing												

Relative Abundance: =High =Medium =Low

Sources: [1] Yoshiyama *et al.* (1998); [2] Moyle (2002); [3] Meyers *et al.* (1998); [4] Lindley *et al.* (2007); [5] CDFG (1998); [6] McReynolds *et al.* (2005); Ward *et al.* (2002, 2003); [7] Snider and Titus (2000)

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002), and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year (YOY), juveniles, or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer Creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2006a). Studies in Butte Creek (Ward *et al.* 2002, 2003; McReynolds *et al.* 2005) found the majority of Central Valley spring-run Chinook salmon migrants to be fry occurring primarily during December through February, and that these movements appeared to be influenced by flow. Small numbers of Central Valley spring-run Chinook salmon remained in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer Creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer Creek juveniles typically exhibit a later YOY migration and an earlier yearling migration (Lindley *et al.* 2006a).

Once juveniles emerge from the gravel, they seek areas of shallow water and low velocities while they finish absorbing the yolk sac (Moyle 2002). Many also will disperse downstream during high-flow events. As is the case of other salmonids, there is a shift in microhabitat use by juveniles to deeper, faster water as they grow. Microhabitat use can be influenced by the presence of predators, which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002). Peak movement of juvenile Central Valley spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to FRH. In 2002, FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to hatchery practices. Because Chinook salmon are not temporally separated in the hatchery, spring-run and fall-run Chinook salmon are spawned together, thus compromising the genetic integrity of the spring-run and early fall-run Chinook salmon stocks. The number of naturally-spawning spring-run Chinook salmon in the Feather River has been estimated only periodically since the 1960s, with estimates ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap with fall-run Chinook salmon (Good *et al.* 2005). For the reasons discussed above, the Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

The Central Valley spring-run Chinook salmon ESU has displayed broad fluctuations in adult abundance, ranging from 1,403 in 1993 to 25,890 in 1982. The average annual abundance for the ESU was 12,590 for the period of 1969 to 1979, 13,334 for the period of 1980 to 1990, 6,554 from 1991 to 2001, and 16,349 between 2002 and 2005 (Pacific Fishery Management Council 2004; CDFG 2004, 2006; Yoshiyama *et al.* 1998). Finally, for the period of 2006 to 2008 the average abundance for the ESU fell back to 6,917 (CDFG 2009). Sacramento River tributary populations in Mill, Deer, and Butte Creeks are probably the best trend indicators for the Central Valley spring-run Chinook ESU as a whole because these streams contain the primary independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991. Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish since 1995. During this same period, adult returns on Mill Creek have averaged 778 fish, and 1,463 fish on Deer Creek. Although recent trends are positive, annual abundance estimates display a high level of fluctuation, and the overall number of Central Valley spring-run Chinook salmon remains well below estimates of historic abundance. In 2008, adult escapement of spring-run declined in several of the region's watersheds. Butte Creek had an estimated 6,000 adults return to the watershed, while more significant decreases occurred on Mill Creek (362 fish), Deer Creek (140 fish), and Antelope Creek (2 fish). In contrast, Clear Creek had a modest increase in returning spring-run adults with an estimated 199 adults returning in 2008. These fluctuations may be attributable to poor ocean conditions that existed when the returning 2008 adults entered the ocean as smolts (spring of 2006) and led to poor ocean survival in the critical ocean entry phase of their life history. Additional factors that have limited adult spawning populations are in-river water quality conditions. In 2002 and 2003, mean water temperatures in Butte Creek exceeded 21°C for 10 or more days in July (Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of columnaris disease (*Flexibacter columnaris*) and ichthyophthiriasis (*Ichthyophthirius multifiis*) in the adult spring-run over-summering in Butte Creek. In 2002, this contributed to the pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run in Butte Creek.

Lindley *et al.* (2006a) concluded that Butte and Deer Creek spring-run Chinook salmon are at low risk of extinction, satisfying viability criteria for population size, growth rate, hatchery influence, and catastrophe. The Mill Creek population is at a low to moderate risk, satisfying some, but not all viability criteria. The Feather and Yuba River populations are data deficient and were not assessed for viability. However, because the existing Central Valley spring-run Chinook salmon populations are spatially confined to relatively few remaining streams in only one of four historic diversity groups, the ESU remains vulnerable to catastrophic disturbance, and remains at a moderate to high risk of extinction.

c. Status of Central Valley Steelhead

Central Valley steelhead were originally listed as threatened on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin River basins in California's Central Valley. In June 2004, NMFS proposed that Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of Central Valley steelhead as threatened (70 FR 37160). This decision also included the Coleman National Fish Hatchery and FRH steelhead populations. These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for Central Valley steelhead on September 2, 2005 (70 FR 52488).

Steelhead can be divided into two life history types, summer-run steelhead and winter-run steelhead, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Only winter steelhead are currently found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento river system prior to the commencement of large-scale dam construction in the 1940s [Interagency Ecological Program (IEP) Steelhead Project Work Team 1999]. At present, summer steelhead are found only in northern California coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

Central Valley steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April, with peaks from January through March, in small streams and tributaries where cool, well oxygenated water is available year-round (table 3, Hallock *et al.* 1961, McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapolov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams.

Spawning occurs during winter and spring months. The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51°F. Fry emerge from the gravel usually about 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Newly-emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although YOY also are abundant in glides and riffles. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small woody debris. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Juvenile Central Valley steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

Some juvenile steelhead may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall. Nobriga and Cadrett (2003) have also verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

Historic Central Valley steelhead run sizes are difficult to estimate given the paucity of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Recent estimates from trawling data in the Delta indicate that approximately 100,000 to 300,000 (mean 200,000) smolts emigrate to the ocean per year, representing approximately 3,600 female Central Valley steelhead spawners in the Central Valley basin (Good *et al.* 2005). This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s.

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks, and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Recent snorkel surveys (1999 to 2002) indicate that steelhead are present in Clear Creek (Newton 2002 *op. cit.* Good *et al.* 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, Central Valley steelhead were thought to be extirpated from the San Joaquin River system. However, recent monitoring has detected small, self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras Rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000).

It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles have also occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005). CDFG staff have prepared juvenile migrant Central Valley steelhead catch summaries on the San Joaquin River near Mossdale, representing migrants from the Stanislaus, Tuolumne, and Merced Rivers. Based on trawl recoveries at Mossdale between 1988 and 2002, as well as rotary screw trap efforts in all three tributaries, CDFG (2003) stated that it is "clear from this data that rainbow trout do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River." The documented returns on the order of single fish in these tributaries suggest that existing populations of Central Valley steelhead on the Tuolumne, Merced, and lower San Joaquin Rivers are severely depressed

Lindley *et al.* (2006) indicated that prior population census estimates completed in the 1990s found the Central Valley steelhead spawning population above RBDD had a fairly strong negative population growth rate and small population size. Good *et al.* (2005) indicated the decline was continuing, as evidenced by new information (Chipps Island trawl data). Central Valley steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. The future of Central Valley steelhead is uncertain due to limited data concerning their status. However, Lindley *et al.* (2007) concluded that there is sufficient evidence to suggest that the ESU is at moderate to high risk of extinction.

Table 3. The temporal occurrence of adult and juvenile Central Valley steelhead in the Central Valley.

Adult Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin[1, 2]												
Sacramento River at Red Bluff[2, 3]												
Mill, Deer Creeks[4]												
Sacramento River at Fremont Weir[6]												
San Joaquin River[7]												
Juvenile Location	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Sacramento River[1, 2]												
Sacramento River at Knights Landing[2, 8]												
Sacramento River at Knights Landing[9]												
Chipps Island (wild)[10]												
Mossdale[8]												
Woodbridge Dam[11]												
Stanislaus River at Caswell[12]												
Sacramento River at Hood[13]												
Relative Abundance:	=High	=Medium	=Low									

Sources: [1] Hallock (1961); [2] McEwan (2001); [3] USFWS unpublished data; [4] CDFG (1995); [5] Hallock *et al.* (1957); [6] Bailey (1954); [7] CDFG Steelhead Report Card Data; [8] CDFG unpublished data; [9] Snider and Titus (2000); [10] Nobriga and Cadrett (2003); [11] Jones & Stokes Associates, Inc. (2002); [12] S.P. Cramer and Associates, Inc. (2000); [13] Schaffter (1980) *d. Status of Southern DPS of North American Green Sturgeon*

The Southern DPS of North American green sturgeon was listed as threatened on April 7, 2006, (70 FR 17386) and includes the North American green sturgeon population spawning in the Sacramento River and utilizing the Sacramento River, the Delta, and the San Francisco Estuary. North American green sturgeon are widely distributed along the Pacific Coast and have been documented offshore from Ensenada, Mexico, to the Bering Sea, and found in rivers from British Columbia to the Sacramento River (Moyle 2002). As is the case for most sturgeon, North American green sturgeon are anadromous; however, they are the most marine-oriented of the sturgeon species (Moyle 2002). In North America, spawning populations of the anadromous green sturgeon currently are found in only three river systems, the Sacramento and Klamath Rivers in California and the Rogue River in southern Oregon.

Two green sturgeon DPS', Northern and Southern, were identified based on evidence of spawning site fidelity (indicating multiple DPS tendencies), and on the preliminary genetic evidence that indicates differences at least between the Klamath River and San Pablo Bay samples (Adams *et al.* 2002). The Northern DPS includes all green sturgeon populations starting with the Eel River and extending northward. The Southern DPS would include all green sturgeon populations south of the Eel River, with the only known spawning population being in the Sacramento River.

The Southern DPS of North American green sturgeon life cycle can be divided into four distinct phases based on developmental stage and habitat use: (1) adult females greater than or equal to 13 years of age and males greater than or equal to 9 years of age, (2) juveniles less than or equal to 3 years of age, (3) larvae and post-larvae less than 10 months of age, and (4) coastal migrant females between 3 and 13 years, and males between 3 and 9 years of age (Nakamoto *et al.* 1995, McLain 2006).

New information regarding the migration and habitat use of the Southern DPS of North American green sturgeon has emerged. Lindley (2006) presented preliminary results of large-scale green sturgeon migration studies, and verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. It appears North American green sturgeon are migrating considerable distances up the Pacific Coast into other estuaries, particularly the Columbia Estuary. This information also agrees with the results of green sturgeon tagging studies (CDFG 2002), where CDFG tagged a total of 233 green sturgeon in the San Pablo Estuary between 1954 and 2001. A total of 17 tagged fish were recovered: 3 in the Sacramento-San Joaquin Estuary, 2 in the Pacific Ocean off of California, and 12 from commercial fisheries off of Oregon and Washington. Eight of the 12 recoveries were in the Columbia Estuary (CDFG 2002).

Kelley *et al.* (2006) indicated that green sturgeon enter the San Francisco Estuary during the spring and remain until autumn. They studied the movement of adults in the San Francisco Estuary and found them to make significant long-distance movements with distinct directionality. The movements were not found to be related to salinity, current, or temperature, and Kelley *et al.* (2006) surmised they are related to resource availability. Green sturgeon were most often found at depths greater than 5 meters with low or no current during summer and autumn months (Erickson *et al.* 2002). The majority of green sturgeon in the Rogue River emigrated from freshwater habitat in December after water temperatures dropped (Erickson *et al.* 2002). They surmised that this holding in deep pools was to conserve energy and utilize abundant food resources. Based on captures of adult green sturgeon in holding pools on the Sacramento River above the Glen-Colusa Irrigation District (GCID) diversion (RM 205), the documented presence of adults in the Sacramento River during the spring and summer months, and the presence of larval green sturgeon in late summer in the lower Sacramento River indicating spawning occurrence, it appears adult green sturgeon could utilize a variety of freshwater and brackish habitats for up to 9 months of the year (Beamesderfer 2006).

Adult green sturgeon are believed to feed primarily upon benthic invertebrates such as clams, mysid and grass shrimp, and amphipods (Radtke 1966, Adams *et al.* 2002). Adult sturgeon caught in Washington State waters were found to have fed on Pacific sand lance (*Ammodytes hexapterus*) and callianassid shrimp (Moyle *et al.* 1992).

Based on the distribution of sturgeon eggs, larva, and juveniles in the Sacramento River, CDFG (2002) indicated that the Southern DPS of North American green sturgeon spawn in late spring and early summer above Hamilton City, possibly to Keswick Dam. Adult green sturgeon are believed to spawn every 3 to 5 years and reach sexual maturity only after several years of growth (*i.e.*, 10 to 15 years) based on sympatric white sturgeon sexual maturity (table 4, CDFG 2002). Adult female green sturgeon produce between 60,000 and 140,000 eggs each reproductive cycle, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al.* 2001). Adults of the Southern DPS of North American green sturgeon begin their upstream spawning migrations into San Francisco Bay in March, reach Knights Landing during April, and spawn between March and July (Heublein 2006). Peak spawning is believed to occur between April and June and thought to occur in deep turbulent pools (Adams *et al.* 2002). Substrate is likely large cobble, but can range from clean sand to bedrock (USFWS 2002). Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length.

After approximately 10 days, larvae begin feeding, growing rapidly, and young green sturgeon appear to rear for the first 1 to 2 months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon appear in USFWS sampling efforts at RBDD from May through August at lengths ranging from 20 to 80 mm fork length (USFWS 2006). The mean yearly total length of post-larval green sturgeon captured in rotary screw traps at the RBDD ranged from 26 mm to 34 mm between 1995 and 2000, indicating they are approximately 2 weeks old. The mean yearly total length of post-larval green sturgeon captured in the GCID rotary screw trap, approximately 30 miles downstream of RBDD, ranged from 33 mm to 44 mm between 1997 and 2005 (CDFG, unpublished data) indicating they are approximately 3 weeks old (Van Eenennaam *et al.* 2001).

Green sturgeon larvae do not exhibit the initial pelagic swim-up behavior characteristic of other *Acipenseridae*. They are strongly oriented to the bottom and exhibit nocturnal activity patterns. Under laboratory conditions, green sturgeon larvae cling to the bottom during the day, and move into the water column at night (Van Eenennaam *et al.* 2001). After 6 days, the larvae exhibit nocturnal swim-up activity (Deng *et al.* 2002) and nocturnal downstream migrational movements

(Kynard *et al.* 2005). Juvenile green sturgeon continue to exhibit nocturnal behavior beyond the metamorphosis from larvae to juvenile stages. Kynard *et al.*'s (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first 6 months of life. When ambient water temperatures reached 46°F, downstream migrational behavior diminished and holding behavior increased. This data suggest that 9-to 10-month-old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds. Juvenile green sturgeon have been salvaged at the Harvey O. Banks Pumping Plant and the John E. Skinner Fish Facility (Fish Facilities) in the South Delta, and captured in trawling studies by CDFG during all months of the year (CDFG 2002). The majority of these fish were between 200 and 500 mm indicating they were from 2 to 3 years of age based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates juvenile of the Southern DPS of North American green sturgeon likely hold in the mainstem Sacramento River, as suggested by Kynard *et al.* (2005).

Population abundance information concerning the Southern DPS of North American green sturgeon is described in the NMFS status reviews (Adams *et al.* 2002, NMFS 2005a). Limited population abundance information comes from incidental captures of North American green sturgeon from the white sturgeon monitoring program by the CDFG sturgeon tagging program (CDFG 2002). By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile North American green sturgeon per year (Adams *et al.* 2002). The only existing information regarding changes in the abundance of the Southern DPS of North American green sturgeon includes changes in abundance at the John E. Skinner Fish Facility between 1968 and 2001. The average number of the Southern DPS of North American green sturgeon taken per year at the State Facility prior to 1986 was 732; from 1986 on, the average per year was 47 (April 7, 2006, 70 FR 17386). For the Harvey O. Banks Pumping Plant, the average number prior to 1986 was 889; from 1986 to 2001 the average was 32 (April 7, 2006, 70 FR 17386). In light of the increased exports, particularly during the previous 10 years, it is clear that the abundance of the Southern DPS of North American green sturgeon is dropping. Additional analysis of North American green and white sturgeon taken at the Fish Facilities indicates that entrainment of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (April 7, 2006, 70 FR 17386). Catches of sub-adult and adult North American green sturgeon by the IEP between 1996 and 2004 ranged from 1 to 212 green sturgeon per year (212 occurred in 2001); however, the portion of the Southern DPS of North American green sturgeon is unknown, as these captures were primarily located in San Pablo Bay, which is known to consist of a mixture of Northern and Southern DPS of North American green

Table 4. The temporal occurrence of adult, larval and post-larval, juvenile, and coastal migrant Southern DPS of North American green sturgeon.

Adult Location (≥13 yrs for females, ≥9 yrs for males)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac River[1, 2, 3]												
SF Bay Estuary[4, 8]												
Larval / Post-Larval Location (≤10 mos)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
RBDD, Sac River[5]												
GCID, Sac River[5]												
Juvenile Location (>10 mos and ≤3 yrs)												
South Delta*[6]												
Sac-SJ Delta[6]												
Sac-SJ Delta[5]												
Suisun Bay[5]												
Coastal Migrant Location (3-13 yrs for females, 3-9 yrs for males)												
Pacific Coast[3, 7]												
Relative Abundance:	=High	=Medium	=Low									

Sources: [1] USFWS (2002); [2] Moyle *et al.* (1992); [3] Adams *et al.* (2002) and NMFS (NMFS 2005a); [4] Kelley *et al.* (2006); [5] CDFG (2002); [6] IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [7] Nakamoto *et al.* (1995); [8] Heublein (2006) *Fish Facility salvage operations sturgeon. Recent spawning population estimates using sibling-based genetics by Israel (2006) indicate a maximum spawning population of 32 spawners in 2002, 64 in 2003, 44 in 2004, 92 in 2005, and 124 in 2006 above RBDD (with an average of 71). Based on the length and estimated age of post-larvae captured at RBDD (approximately 2 weeks of age) and GCID (downstream; approximately 3 weeks of age), it appears the majority of the Southern DPS of North American green sturgeon are spawning above RBDD. Note, there are many assumptions with this interpretation (*i.e.*, equal sampling efficiency and distribution of post-larvae across channels) and this information should be considered cautiously. While green sturgeon populations were not analyzed in the recent salmonid population viability papers (Lindley *et al.* 2006, 2007) and NMFS' status reviews (Adams *et al.* 2002, NMFS 2005a), the information that is available on green sturgeon indicates that, as with Sacramento River winter-run Chinook salmon, the mainstem Sacramento River may be the last viable spawning habitat for the Southern DPS of North American green sturgeon (NMFS 2003). Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term. Although the extinction risk of the Southern DPS of green sturgeon has not been assessed, NMFS believes that the extinction risk has increased because there is only one population, within the mainstem Sacramento River.

There are at least two records of confirmed adult sturgeon observation in the Feather River (Beamesderfer *et al.* 2004); however, there are no observations of juvenile or larval sturgeon even prior to the 1960s when Oroville Dam was built (NMFS 2005a). There are also unconfirmed reports that green sturgeon may spawn in the Feather River during high flow years (CDFG 2002).

Spawning in the San Joaquin River system has not been recorded, but alterations of the San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced Rivers) and its mainstem occurred early in the European settlement of the region. During the later half of the 1800s, impassable barriers were built on these tributaries where the water courses left the foothills and entered the valley floor. Therefore, these low elevation dams have blocked potentially suitable spawning habitats located further upstream for over a century. Additional destruction of riparian and stream channel habitat by industrialized gold dredging further disturbed any valley floor habitat that was still available for sturgeon spawning. Both white and green sturgeon likely utilized the San Joaquin River basin for spawning prior to the onset of European influence, based on past use of the region by populations of Central Valley spring-run Chinook salmon and Central Valley steelhead. These two populations of salmonids have either been extirpated or greatly diminished in their use of the San Joaquin River basin over the past two centuries.

The freshwater habitat of North American green sturgeon in the Sacramento-San Joaquin drainage varies in function, depending on location. Spawning areas currently are limited to accessible upstream reaches of the Sacramento River. Preferred spawning habitats are thought to contain large cobble in deep, cool pools with turbulent water (CDFG 2002, Moyle 2002).

Migratory corridors are downstream of the spawning areas and include the mainstem Sacramento River and the Delta. These corridors allow the upstream passage of adults and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly screened diversions, and degraded water quality. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their 1 to 3 year residence in freshwater. Rearing habitat condition and function may be affected by variation in annual and seasonal flow and temperature characteristics.

B. Status of Critical Habitat and Primary Constituent Elements for Listed Salmonids

The designated critical habitat for Sacramento River winter-run Chinook salmon includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Estuary to the Golden Gate Bridge north of the San Francisco/Oakland Bay Bridge. In the Sacramento River, critical habitat includes the river water column, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. In the areas westward of Chipps Island, critical habitat includes the estuarine water column and essential foraging habitat and food resources used by Sacramento River winter-run Chinook salmon as part of their juvenile emigration or adult spawning migration.

Critical habitat for Central Valley spring-run Chinook salmon includes stream reaches such as those of the Feather and Yuba Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear Creeks, and the Sacramento River and Delta. Critical habitat for Central Valley steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope Creeks in the Sacramento River basin; and, the San Joaquin River its tributaries, and the Delta.

Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (September 2, 2005, 70 FR 52488). The bankfull elevation is defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series (Dunne and Leopold 1978, MacDonald *et al.* 1991, Rosgen 1996). Critical habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead is defined as specific areas that contain the primary constituent elements (PCE) and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for Central Valley spring-run Chinook salmon and Central Valley steelhead, and as physical habitat elements for Sacramento River winter-run Chinook salmon.

1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for Chinook salmon and steelhead is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for Sacramento River winter-run Chinook salmon is restricted to the Sacramento River primarily between RBDD and Keswick Dam. Central Valley spring-run Chinook salmon also spawn in the mainstem Sacramento River between RBDD and Keswick Dam and in tributaries such as Mill, Deer, and Butte Creeks. Spawning habitat for Central Valley steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly below dams throughout the Central Valley. Most remaining natural spawning habitats (those not downstream from large dams) are currently in good condition, with adequate water temperatures, stream flows, and gravel conditions to support successful reproduction. Some areas below dams, especially for steelhead, are degraded by fluctuating flow conditions related to water storage and flood management that scour or strand redds. Regardless of its current condition, spawning habitat in general has a high intrinsic value, as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover, such as shade, submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries may also be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system [*e.g.*, the lower Cosumnes River, Sacramento River reaches with set-back levees (*i.e.*, primarily located upstream of the City of Colusa)]. However, the channeled, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high intrinsic value to salmonids, as the juvenile life stages are dependant on the function of this habitat for successful survival and recruitment. Thus, although much of the rearing habitat is in poor condition, it is important to the species.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of obstruction with water quantity and quality conditions and contain natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility, survival and food supply. Migratory corridors are downstream of the spawning area and include the lower Sacramento River and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly-screened diversions, and degraded water quality. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and much of the Sacramento River is not a problem, but problems exist on many tributary streams, and at the RBDD. For juveniles, unscreened or inadequately screen water diversions throughout their migration corridors and a scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic value to the species.

4. Estuarine Areas

Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover, such as submerged and overhanging large wood, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high intrinsic value because they function as rearing habitat and as an area of transition to the ocean environment.

C. Status of Proposed Critical Habitat and PCEs for the Southern DPS of North American Green Sturgeon

Critical habitat was proposed for Southern DPS of green sturgeon on September 8, 2008 (73 FR 52084). Proposed critical habitat for Southern DPS of green sturgeon includes approximately 325 miles of riverine habitat and 1,058 square miles of estuarine habitat in California, Oregon, and Washington, and 11,927 square miles of coastal marine habitat off California, Oregon, and Washington within the geographical area presently occupied by the Southern DPS of green sturgeon. In addition, approximately 136 square miles of habitat within the Yolo and Sutter bypasses, adjacent to the Sacramento River, California, are proposed for designation.

1. Food Resources

Abundant food items for larval, juvenile, subadult, and adult life stages should be present in sufficient amounts to sustain growth (larvae, juveniles, and subadults) or support basic metabolism (adults). Although we lack specific data on food resources for green sturgeon within freshwater riverine systems, nutritional studies on white sturgeon suggest that juvenile green sturgeon most likely feed on macro benthic invertebrates which can include plecoptera (stoneflies), ephemeroptera (mayflies), trichoptera (caddis flies), chironomid (dipteran fly larvae), oligochaetes (tubifex worms) or decapods (crayfish). These food resources are important for juvenile foraging, growth, and development during their downstream migration to the Delta and bays. In addition, subadult and adult green sturgeon may forage during their downstream post-spawning migration or on non-spawning migrations within freshwater rivers. Subadult and adult green sturgeon in freshwater rivers most likely feed on benthic invertebrates similar to those fed on in bays and estuaries, including freshwater shrimp and amphipods. Many of these different invertebrate groups are endemic to and readily available in the Sacramento River from Keswick Dam downstream to the Delta. Heavy hatches of mayflies, caddis flies, and chironomids occur in the upper Sacramento River, indicating that these groups of invertebrates are present in the river system. NMFS anticipates that the aquatic life stages of these insects (nymphs, larvae) would provide adequate nutritional resources for green sturgeon rearing in the river.

2. Substrate Type or Size

Suitable critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development (*e.g.*, bedrock sills and shelves, cobble and gravel, or hard clean sand, with interstices or irregular surfaces to "collect" eggs and provide protection from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (*e.g.*, substrates with interstices or voids providing refuge from predators and from high flow conditions), and subadults and adult life stages (*e.g.*, substrates for holding and spawning). For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett *et al.*, 1991, Moyle *et al.* 1995). Eggs likely adhere to substrates, or settle into crevices between substrates (Deng 2000, Van Eenennaam *et al.* 2001, and Deng *et al.* 2002). Both embryos and larvae exhibited a strong affinity for benthic structure during laboratory studies (Van Eenennaam *et al.* 2001, Deng *et al.* 2002, Kynard *et al.* 2005), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (Nguyen and Crocker 2007). Recent stream surveys by USFWS and Reclamation biologists have identified approximately 54 suitable holes and pools between Keswick Dam and approximately GCID that would support spawning or holding activities for green sturgeon based on the identified physical criteria. Many of these locations are at the confluence of tributaries with the mainstem Sacramento River or at bend pools. Observations of channel type and substrate compositions during these surveys indicate that appropriate substrate is available in the Sacramento River between GCID and Keswick Dam. Ongoing surveys are anticipated to further identify river reaches with suitable substrate characteristics in the upper river and their utilization by green sturgeon.

3. Water Flow

An adequate flow regime (*i.e.*, magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11 - 19°C) (Cech *et al.* 2000, Mayfield and Cech 2004, Van Eenennaam *et al.* 2005, Allen *et al.* 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning success is most certainly associated with water flow and water temperature compared to other variables. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs (average daily water flow during spawning months: 6,900 – 10,800 cfs; Brown 2007). Post-spawning downstream migrations are triggered by increased flows, ranging from 6,150 – 14,725 cfs in the late summer (Vogel 2005) and greater than 3,550 cfs in the winter (Erickson *et al.* 2002; Benson *et al.* 2007). The current suitability of these flow requirements is almost entirely dependent on releases from Shasta Dam. High winter flows associated with the natural hydrograph do not occur within the section of the river utilized by green sturgeon with the frequency and duration that was seen in pre-dam conditions. Rearrangement of the river channel and the formation of new pools and holes are unlikely to occur given the management of the river's discharge to prevent downstream flooding.

4. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages are required for the properly functioning of the freshwater habitat. Suitable water temperatures would include: stable water temperatures within spawning reaches (wide fluctuations could increase egg mortality or deformities in developing embryos); temperatures within 11 - 17°C (optimal range = 14 - 16°C) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.* 2005); temperatures below 20°C for larval development (Werner *et al.* 2007); and temperatures below 24°C for juveniles (Mayfield and Cech 2004 and Allen *et al.* 2006). Due to the temperature management of the releases from Keswick Dam for winter-run in the upper Sacramento River, water temperatures in the river reaches utilized currently by green sturgeon appear to be suitable for proper egg development and larval and juvenile rearing. Suitable salinity levels range from fresh water (< 3‰) for larvae and early juveniles (about 100 days post hatch [dph]) to brackish water (10‰) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Salinity levels are suitable for green sturgeon in the Sacramento River and freshwater portions of the Delta for early life history stages. Adequate levels of dissolved oxygen are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1} for juveniles; Allen and Cech 2007). Current mainstem dissolved oxygen levels are suitable to support the growth and migration of green sturgeon in the Sacramento River. Suitable water quality would also include water free of contaminants (i.e., pesticides, organochlorines, elevated levels of heavy metals, *etc.*) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Water free of such contaminants would protect green sturgeon from adverse impacts on growth, reproductive development, and reproductive success (*e.g.*, reduced egg size and abnormal gonadal development, abnormal embryo development during early cleavage stages and organogenesis) likely to result from exposure to contaminants (Fairey *et al.* 1997, Foster *et al.* 2001a, Foster *et al.* 2001b, Kruse and Scarnecchia 2002, Feist *et al.* 2005, and Greenfield *et al.* 2005). Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin.

5. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for passage within riverine habitats and between riverine and estuarine habitats (*e.g.*, an unobstructed river or dammed river that still allows for passage). Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning/rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick

Dam (RM 301) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242). The effects of closure of RBDD on critical habitat is being analyzed in the OCAP consultation. The proposed pumping facilities and operations do not significantly further restrict or impact the migratory corridor of green sturgeon. Closure of the gates at RBDD from May 15 through September 15 currently precludes all access to spawning grounds above the dam during that time period. Adult green sturgeon that cannot migrate upstream past the RBDD either spawn in what is believed to be less suitable habitat downstream of the RBDD (potentially resulting in lower reproductive success) or migrate downstream without spawning, both of which would reduce the overall reproductive success of the species.

Adult green sturgeon that were successful in passing the RBDD prior to its closure have to negotiate the dam on their subsequent downstream migration following spawning during the gates down period. Recent acoustic tag data indicates that some fish are successful in passing the dam when the gates are in the "closed" position (Heublein *et al.* 2008). Typically the gates are raised slightly from the bottom to allow water to flow underneath the radial gates and fish apparently can pass beneath the radial gates during this period. However, recent observed mortalities of green sturgeon during an emergency gate operation (2007) indicate that passage is not without risk if the clearance is too narrow for successful passage.

Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July, during the RBDD gates down period. Juvenile green sturgeon would likely be subjected to the same predation and turbulence stressors caused by RBDD as the juvenile anadromous salmonids, leading to diminished survival through the structure and waters immediately downstream.

6. <u>Depth</u>

Deep pools of $\geq$ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River above GCID. The significance and purpose of these aggregations are unknown at the present time, although it is likely that they are the result of an intrinsic behavioral characteristic of green sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson *et al.* 2002, Benson *et al.* 2007). As described above, approximately 54 pools with adequate depth have been identified in the Sacramento River above the GCID location.

7. <u>Sediment Quality</u>

Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g.*, elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), polyaromatic hydrocarbons (PAHs), and organochlorine pesticides] that can result in negative effects on any life stages of green sturgeon. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may negatively affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento

River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers which result in deposition of these materials in the sediment horizons in the river channel. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate the sequestered contaminants into the river. This is a continuing concern in the river's watershed.

8. Summary

The current condition of proposed critical habitat for the Southern DPS of green sturgeon is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species, particularly in the upstream riverine habitat. In particular, passage and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the Southern DPS of green sturgeon evolved. The habitat values proposed for green sturgeon critical habitat have suffered similar types of degradation as those previously described for winter-run Chinook salmon critical habitat. In addition, the alterations to the Sacramento-San Joaquin River Delta, as part of proposed critical habitat, may have a particularly strong impact on the survival and recruitment of juvenile green sturgeon due to the protracted rearing time in the delta and estuary. Loss of individuals during this phase of the life history of green sturgeon represents losses to multiple year classes rearing in the delta, which can ultimately impact the potential population structure for decades to come.

D. Factors Affecting the Status of Listed Species and Critical Habitat

1. Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon and Central Valley Steelhead

California's robust agricultural economy and rapidly increasing urban growth place high demand for water in the Sacramento and San Joaquin River basins. The demand for water in the Central Valley has significantly altered the natural morphology and hydrology of the Sacramento and San Joaquin Rivers and their major tributaries. Agricultural lands and urban areas have flourished on historic floodplains. An extensive flood management system of dams, levees, and bypass channels restricts the river's natural sinuosity and reduces the lag time of water flowing through the system. A complex network of water delivery systems has transformed much of the Central Valley drainage system into a series of reservoirs, diversion facilities and lined conveyance channels. Flood management and water delivery systems, in addition to agricultural, grazing, and urban land uses, are the main anthropogenic factors affecting watersheds upon which listed salmonids depend.

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley (*e.g.*, Busby *et al.* 1996, Myers *et al.* 1998, Good *et al.* 2005, CALFED 2000). NMFS has also assessed the factors contributing to Chinook salmon and steelhead decline in supplemental documents (NMFS 1996, 1998) and Federal Register notices (*e.g.*, June 16, 1993, 58 FR 33212; January 4, 1994, 59 FR 440; May 6, 1997, 62 FR 24588; August 18, 1997, 62 FR

43937; March 19, 1998, 63 FR 13347; May 5, 1999, 64 FR 24049; September 16, 1999, 64 FR 50394; February 16, 2000, 65 FR 7764). The foremost reason for the decline in these anadromous salmonid populations is the degradation and/or destruction of habitat (*e.g.*, substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, and migration conditions). Additional factors contributing to the decline of these populations include: over-utilization, disease or predation, the inadequacy of existing regulatory mechanisms, and other natural and manmade factors including global climate change. All of these factors have contributed to the ESA-listing of these fish and deterioration of their critical habitats. However, it is widely recognized in numerous species accounts in the peer-reviewed literature that the modification and curtailment of habitat and range have had the most substantial impacts on the abundance, distribution, population growth, and diversity of salmonid ESUs and DPSs. Although habitat and ecosystem restoration has contributed to recent improvements in habitat conditions throughout the ESUs/DPSs, global climate change remains a looming threat.

a. Modification and Curtailment of Habitat and Range

Modification and curtailment of habitat and range from hydropower, flood control, and consumptive water use have permanently blocked or hindered salmonid access to historical spawning and rearing grounds, resulting in the complete loss of substantial portions of spawning, rearing, and migration PCEs. Clark (1929) estimated that there were originally 6,000 linear miles of salmon habitat in the Central Valley system, and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 linear miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today. Yoshiyama *et al.* (1996) surmised that steelhead habitat loss was even greater than salmon loss, as steelhead migrated farther into drainages. In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and the Delta block salmon and steelhead access to the upper portions of their respective watersheds. The loss of upstream habitat had required Chinook salmon and steelhead to use less hospitable reaches below dams. The loss of substantial habitat above dams also has resulted in decreased juvenile and adult steelhead survival during migration, and in many cases, had resulted in the dewatering and loss of important spawning and rearing habitats.

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted stream flows and altered the natural cycles by which juvenile and adult salmonids have evolved. Changes in stream flows and diversions of water affect spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and instream woody material. More uniform flows year-round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement, caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams.

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al.* 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). High water temperatures in the Sacramento River have limited the survival of young salmon.

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of channels and diversions to increase channel elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects that have diminished conditions for adult and juvenile migration and survival.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization and riprapping include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al.* 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

Large quantities of downed trees are a functionally important component of many streams (NMFS 1996). Large woody debris influences channel morphology by affecting longitudinal profile, pool formation, channel pattern and position, and channel geometry. Downstream transport rates of sediment and organic matter are controlled in part by storage of this material behind large wood. Large wood affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (NMFS 1996). Wood enters streams inhabited by salmonids either directly from adjacent riparian zones or from riparian zones in adjacent non-fish bearing tributaries. Removal of riparian vegetation and instream woody material from the streambank results in the loss of a primary source of overhead and instream cover for juvenile salmonids. The removal of riparian vegetation and instream woody material and the replacement of natural bank substrates with rock revetment can adversely affect important ecosystem functions. Living space and food for terrestrial and aquatic invertebrates is lost, eliminating an important food source for juvenile salmonids. Loss of riparian vegetation and soft substrates reduces inputs of organic material to the stream ecosystem in the form of leaves, detritus, and woody debris, which can affect biological production at all trophic levels.

In addition, the armoring and revetment of stream banks tends to narrow rivers, reducing the amount of habitat per unit channel length (Sweeney *et al.* 2004). As a result of river narrowing, benthic habitat decreases and the number of macroinvertebrates, such as stoneflies and mayflies, per unit channel length decreases affecting salmonid food supply.

b. Ecosystem Restoration

The Central Valley Project Improvement Act (CVPIA), implemented in 1992, requires that fish and wildlife receive equal consideration with other demands for water allocations derived from the Central Valley Project. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward doubling the natural populations of select anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the Department of the Interior's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

Two programs included under CALFED; the Ecosystem Restoration Program (ERP) and the Environmental Water Account, were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids, and emphasis has been placed in tributary drainages with high potential for Central Valley steelhead and spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by the CALFED-ERP have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids.

The California Department of Water Resources' (CDWR) Four Pumps Agreement Program has approved approximately $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement's inception in 1986. Four Pumps projects that benefit Central Valley spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Estuary upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Additionally, predator habitat isolation and removal and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead.

c. *Natural Fluctuations in Ocean Conditions and Global Climate Change*

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al.* 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale ocean temperature shifts, such as El Niño, appear to change ocean productivity, and can have significant effects on rainfall in the Central Valley

Another key factor affecting many West Coast fish stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. NMFS presumes that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of CWT recoveries from subadults relative to the number of CWTs released from that brood year.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although to what degree is not known. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations—following their protection under the Marine Mammal Protection Act of 1972—has substantially increased salmonid mortality.

Finally, the unusual drought conditions in 2001 warrant additional consideration. Flows in 2001 were among the lowest flow conditions on record. The available water in the Sacramento and San Joaquin River watersheds was 70 percent and 66 percent of normal, according to the Sacramento River Index and the San Joaquin River Index, respectively. The juveniles that passed downriver during the 2001 spring and summer out migration were likely affected, and this, in turn, likely affected adult returns primarily in 2003 and 2004, depending on the stock and species.

d. *Global Climate Change*

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (Intergovernmental Panel on Climate Change 2001). Much of that increase will likely occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data, Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

An alarming prediction is the fact that Sierra snow packs are expected to decrease with global warming and that the majority of runoff in California will be from rainfall in the winter rather than from melting snow pack in the mountains (CDWR 2006). This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt-dominated system to a winter rain dominated system. This would likely truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold-water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, could rise above thermal tolerances for juvenile and adult salmonids (*e.g.*, Sacramento River winter-run Chinook salmon and Central Valley steelhead) that must hold below Keswick Dam over the summer and fall periods.

2. Critical Habitat for Salmonids

According to NMFS' (2005b) Critical Habitat Analytical Review Team (CHART) report, the major categories of habitat-related activities affecting Central Valley salmonids include: (1) irrigation impoundments and withdrawals, (2) channel modifications and levee maintenance, (3) the presence and operation of hydroelectric dams, (4) flood control and streambank stabilization, and (5) exotic and invasive species introductions and management. All of these activities affect PCEs via their alteration of one or more of the following: stream hydrology, flow and water-level modification, fish passage, geomorphology and sediment transport, temperature, DO levels, nearshore and aquatic vegetation, soils and nutrients, physical habitat structure and complexity, forage, and predation (Spence *et al.* 1996). According to the CHART report (NMFS 2005b), the condition of critical habitat varies throughout the range of the species. Generally, the conservation value of existing spawning habitat ranges from moderate to high quality, with the primary threats including changes to water quality, and spawning gravel composition from rural, suburban, and urban development, forestry, and road construction and maintenance. Downstream, river and estuarine migration and rearing corridors range in condition from poor to high quality depending on location. Tributary migratory and rearing corridors tended to rate as moderate quality due to threats to adult and juvenile life stages from irrigation diversion, small dams, and water quality. Delta (*i.e.*, estuarine) and mainstem Sacramento and San Joaquin River reaches tended to range from poor to high quality, depending on location. In the alluvial reach of the Sacramento River between Red Bluff and Colusa, the PCEs of rearing and migration habitat are in good condition because, despite the influence of upstream dams, this reach retains natural, and functional channel processes that maintain and develop anadromous fish habitat. The river reach downstream from Colusa and including the Delta is poor in quality due to impaired hydrologic conditions from dam operations, water quality from agriculture, degraded nearshore and riparian habitat from levee construction and maintenance, and habitat loss and fragmentation.

3. Southern DPS of North American Green Sturgeon

The principal factors for the decline in the Southern DPS of North American green sturgeon are reviewed in the listing notice (April 7, 2006, 70 FR 17386) and status reviews (Adams *et al.* 2002, NMFS 2005a), and primarily consist of: (1) the present or threatened destruction, modification, or curtailment of habitat or range; (2) poor water quality; (3) over-utilization;

(4) increased water temperatures; (5) non-native species; and (6) other natural and manmade factors, including habitat and ecosystem restoration, and global climate change.

NMFS (2005a) concluded that the principle threat to green sturgeon is impassible barriers, primarily Keswick and Shasta Dams on the Sacramento River and Oroville Dam on the Feather River that likely block and prevent access to historic spawning habitat (NMFS 2005a). Spawning habitat may have extended up into the three major branches of the Sacramento River; the Little Sacramento River, the Pit River system, and the McCloud River (NMFS 2005a). In contrast, recent modeling evaluations by Mora (2006) indicate little or no habitat in the Little Sacramento River or the Pit River exists above Shasta Dam; however, a considerable amount of habitat exists above Shasta on the mainstem Sacramento River. Green and white sturgeon adults have been observed periodically in the Feather and Yuba Rivers (USFWS 1995, Beamesderfer *et al.* 2004, McLain 2006), and habitat modeling by Mora (2006) suggests there is suitable habitat above Oroville Dam. There are no records of larval or juvenile white or green sturgeon being captured on the Yuba or Feather Rivers; however, there are reports that green sturgeon may reproduce in the Feather River during high flow years (CDFG 2002), but these are unconfirmed.

No green sturgeon have been documented in the San Joaquin River; however, the presence of white sturgeon has been documented (USFWS 1995, Beamesderfer *et al.* 2004), making green sturgeon presence historically likely, as the two species require similar habitat and their ranges overlap in the Sacramento River. Habitat modeling by Mora (2006) also suggests sufficient conditions are present in the San Joaquin River to Friant Dam, and in the Stanislaus, Tuolumne, and Merced Rivers to their respective dams. In addition, the San Joaquin River had the largest spring-run Chinook salmon population in the Central Valley prior to the construction of Friant Dam (Yoshiyama *et al.* 2001) with escapements approaching 500,000 fish. Thus, based on prior spring-run Chinook salmon distribution and habitat use in the San Joaquin River, it is very possible that green sturgeon were extirpated from the San Joaquin River basin in a similar manner to spring-run Chinook salmon. The loss of potential green sturgeon spawning habitat on the San Joaquin River also may have contributed to the overall decline of the Southern DPS of North American green sturgeon.

The potential effects of climate change were discussed in the Chinook salmon and Central Valley steelhead sections and primarily consist of altered ocean temperatures and stream flow patterns in the Central Valley. Changes in Pacific Ocean temperatures can alter predator-prey relationships and affect migratory habitat of the Southern DPS of North American green sturgeon. Increases in rainfall and decreases in snow pack in the Sierra Nevada range will affect cold-water pool storage in reservoirs affecting river temperatures. As a result, the quantity and quality of spawning and rearing habitat that may be available to the Southern DPS of North American green sturgeon will likely significantly decrease.

4. <u>Proposed Critical Habitat for the Southern DPS of North American Green Sturgeon</u>

Similar to the listed salmonids, the Southern DPS of North American green sturgeon have been negatively impacted by dam construction and the associated hydroelectric and water storage operations in the Central Valley which ultimately affect the hydrology and accesibility of Central Valley rivers and streams to anadromous fish. Anthropogenic manipulations of the aquatic habitat, such as introduction of non-native species, dredging, bank stabilization, and water pollution have also degraded the quality of the Central Valley's waterways for green sturgeon.

IV. ENVIRONMENTAL BASELINE

The environmental baseline "includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR §402.02).

Historically, as water from the Sacramento River entered the Delta area it would naturally change its course as it meandered towards San Francisco Bay. The course changes were dictated by size of the flows, the land elevations, erosion and a broad range of other naturally occurring dynamics. As the surrounding lands were developed into farms, urban, and suburban areas, it became advantageous to confine the flowing water to a prescribed system of channels; levees were built along the channel banks to assure that flows would stay within those channels. The land surrounding the Sacramento River Delta now has a lower elevation than the water surface of the channels, and failure of the levees would lead to wide-spread flooding and damage to the adjacent land developments. To prevent that, the levees are armored with reinforcing materials whenever they show signs of weakness. This has been an ongoing method of treatment and the repairs have been accomplished by individual land-owners, levee maintenance districts, and government institutions at all levels. Some of the repairs are primitive and some well-designed, but because most of the levees were originally built out of sand dredged from the river bottom, they are inherently weak, and the need to repair them is an ongoing challenge.

Numerous studies, many of which are cited in this opinion, have demonstrated that removal of woody material, shading, and natural riparian vegetation from riverbanks is detrimental to the listed species covered in this opinion. The action area (the Sacramento River Delta) was one of the earliest reaches of the river system to undergo these changes, and the runs of anadromous salmonids continued for many years to be robust in spite of it. However, in recent decades, the cumulative effects of changes to the river system (dams, diversions, channelization, etc.) have caused populations of anadromous salmonids to decline. The action area is primarily a migration corridor for adult returning from the Pacific Ocean to spawn upstream in the Sacramento and its tributaries, and for the juveniles that are migrating seaward.

A. Status of the Species in the Action Area

The action area functions as a migratory corridor for adult Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and provides migration and rearing habitat for juveniles of these species. A large proportion of all Federally listed Central Valley salmonids are expected to utilize aquatic habitat within the action area. The action area also functions as a migratory and holding corridor for adults, and juvenile rearing and migratory habitat of Southern DPS of North American green sturgeon.

1. Sacramento River Winter-Run Chinook Salmon

Sacramento River winter-run Chinook salmon are currently present in the Sacramento River below Keswick Dam, and are composed of a single breeding population (*Status of the Species and Critical Habitat* section). The entire population of migrating adults and emigrating juveniles must pass through the action area.

A detailed assessment of the migration timing of Sacramento River winter-run Chinook salmon was reviewed in the *Status of the Species and Critical Habitat* section. Adult Sacramento River winter-run Chinook salmon is expected to be present in the Sacramento River portion of the action area between November and June (Myers et al. 1998, Good et al. 2005) as they migrate to spawning grounds. Juvenile Sacramento River winter-run Chinook salmon migration patterns in the Sacramento River and Steamboat Slough can best be described by temporal migration characteristics found by the USFWS (2001) in beach seine captures along the lower Sacramento River between Sacramento and Princeton, and in the Delta south of Sacramento along the Sacramento River, and in nearby channels such as Steamboat and Georgiana sloughs. Because beach seining samples the shoreline rather than the center of the channel as is often the case in rotary screw traps and trawls, it is considered the most accurate sampling effort in predicting the nearshore presence of salmonids. In the Sacramento River, between Princeton and Sacramento, juveniles are expected between November and mid April with the highest densities observed first during November and December, and second during January through March. The presence of juvenile Sacramento River winter-run Chinook salmon in Steamboat slough is dependant on hydrologic conditions and the species exposure to them in the north Delta (Jeff McLain, NMFS, pers. Comm.., 2006). For example, the operation of the DCC gates affects Sacramento River flow entering Steamboat Slough. In most cases, past catches of Sacramento River winter-run Chinook salmon juveniles in Steamboat slough have been relatively low.

2. Central Valley Spring-Run Chinook Salmon

Central Valley spring-run Chinook salmon populations currently spawn in the Sacramento River below Keswick Dam, the low-flow channel of the Feather River, and in the Sacramento River tributaries including Mill, Deer, Antelope, and Butte Creeks (CDFG 1998). The entire population of migrating adults and emigrating juveniles must pass through the action area. Adult Central Valley spring-run Chinook salmon are expected on the Sacramento River between March and July (Myers et al. 1998, Good et al. 2005). Peak presence is believed to be during February and March (CDFG 1998). In the Sacramento River, juveniles may begin migrating downstream almost immediately following emergence from the gravel with most emigration occurring from December through March (Moyle et. al. 1989, Vogel and Marine 1991). Snider and Titus (2000) observed that up to 69 percent of spring-run Chinook salmon emigrate during the first migration phase between November and early January. The remainder of the Central Valley spring-run Chinook salmon emigrates during subsequent phases that extend into early June. The age structure of emigrating juveniles is comprised of young of year and yearlings. The exact composition of the age structure is not known, although populations from Mill and Deer Creek primarily emigrate as yearlings (Colleen Harvey-Arrison, CDFG, pers. Comm., 2004), and populations from Butte Creek primarily emigrate as fry (Ward et. al. 2002). Younger juveniles are found closer to the shoreline than older individuals (Healey 1991). As in the case for

Sacramento River winter-run Chinook salmon, the presence of juvenile Central Valley spring-run Chinook salmon in Steamboat slough is dependant on hydrologic conditions and the species exposure to them in the north Delta (Jeff McLain, NMFS, pers. comm., 2006). In most cases, past catches of Central Valley spring-run Chinook salmon juveniles in Steamboat slough have been relatively low.

3. Central Valley Steelhead

Central Valley steelhead populations currently spawn in tributaries to the Sacramento and San Joaquin Rivers. The proportion of steelhead in this DPS that migrate through the action area is unknown. However, the vast majority of Central Valley steelhead spawn and rear in the Sacramento River arm of the system, and thus would have to pass through the action area on their way to and from the ocean. Adult steelhead may be present in all parts of the action area from June through March, with the peak occurring between August and October (Bailey 1954, Hallock et. al. 1957). The highest abundance of adults and juveniles is expected in the Sacramento River part of the action area. Juvenile steelhead emigrate through the Sacramento River from late fall to spring. Snider and Titus (2000) observed that juvenile steelhead emigration primarily occurs between November and May at Knights Landing. The majority of juvenile steelhead emigrate as yearlings and are assumed to be primarily utilizing the center of the channel rather than the shoreline.

4. Southern DPS of North American Green Sturgeon

The spawning population of the Southern DPS of North American green sturgeon is currently restricted to the Sacramento River below Keswick Dam, and is composed of a single breeding population (*Status of the Species and Critical Habitat* section), thus the entire population of adults and juveniles must pass through the action area.

Adult Southern DPS of North American green sturgeon migrate upstream through the action area primarily between March and June (Adams et. al. 2002). Larva and post-larvae are present on the lower Sacramento River and Steamboat Slough between May and October, primarily during June and July (CDFG 2002). Small numbers of juvenile Southern DPS of North American green sturgeon have been captured at various locations on the Sacramento River as well as in the Delta (in the action area downstream of Sacramento) during all months of the year (IEP Database, Borthwick et. al. 1999).

B. Factors Affecting the Species and Habitat in the Action Area

1. Sacramento River Winter-Run Chinook Salmon, Central Valley Spring-Run Chinook Salmon, and Central Valley Steelhead.

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs affecting listed salmonids in the action area. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks.

Consequently, the mainstream of the river often remains too high and turbid to provide quality rearing habitat. High water temperatures also limit habitat availability for listed salmonids in the lower Sacramento River. High summer water temperatures in the lower Sacramento River can exceed 72°F, and create a thermal barrier to the migration of adult and juvenile salmonids (Kjelson *et al.* 1982).

Levee construction and bank protection have affected salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and SRA. Individual bank protection sites for this project are in the range of a few hundred linear feet in length. Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites; and (2) reach-level impacts which are the accumulative impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach (USFWS 2000). Revetted embankments result in loss of sinuosity and braiding and reduce the amount of aquatic habitat.

Impacts at the reach level result primarily from halting erosion and controlling riparian vegetation. Reach-level impacts which cause significant impacts to fish are reductions in new habitats of various kinds, changes to sediment and organic material storage and transport, reductions of lower food-chain production, and reduction in IWM.

The use of rock armoring limits recruitment of IWM (*i. e.*, from non-riprapped areas), and greatly reduces, if not eliminates, the retention of IWM once it enters the river channel. Riprapping creates a relatively clean, smooth surface which diminishes the ability of IWM to become securely snagged and anchored by sediment. IWM tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological function are thus greatly reduced, because wood needs to remain in place to generate maximum values to fish and wildlife (USFWS 2000). Recruitment of IWM is limited to any eventual, long-term tree mortality and whatever abrasion and breakage many occur during high flows (USFWS 2000). Juvenile salmonids are likely being impacted by reductions, fragmentation, and general lack of connectivity of remaining nearshore refuge areas.

2. <u>Southern Distinct Population Segment of North American Green Sturgeon</u>

The Sacramento River is utilized by larvae, post-larvae, and to a lesser extent, juvenile North American green sturgeon for rearing and migration purposes. Although it is believed that larvae, post-larvae, and juveniles are primarily benthic (with the exception of the post-larvae nocturnal swim-up behavior which is believed to be a dispersal mechanism), the massive channelization effort in the action area has resulted in a loss of ecosystem properties (USFWS 2000, Sweeney *et al.* 2004). Channelization results in reduced food supply (aquatic invertebrates), and reduced pollutant processing, organic matter processing, and nitrogen uptake (Sweeney *et al.* 2004).

Point source and non-point source pollution resulting from agricultural discharge and urban and industrial development occurs in the action area. Environmental stresses as a result of low water quality can lower reproductive success and may account for low productivity rates of green sturgeon (Klimley 2002). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element concentrations may deleteriously affect early life-stage survival of fish in the Sacramento River (USFWS 1995). Principle sources of organic contamination in the Sacramento River are rice field discharges from Butte Slough, Reclamation District 108, Colusa Basin Drain, Sacramento Slough, and Jack Slough (USFWS 1995). In addition, organic contaminants from agricultural returns, urban and agricultural runoff from storm events, and high trace element concentrations may deleteriously affect early life-stage survival of green sturgeon.

The high numbers of diversions in the action area on the Sacramento River and in the Delta are a potential threat to North American green sturgeon due to juvenile entrainment into these diversions.

C. Factors affecting critical habitat

1. Sacramento River Winter-Run Chinook Salmon, Central Valley Spring-Run Chinook Salmon, and Central Valley Steelhead.

According to NMFS' (2005b) Critical Habitat Analytical Review Team (CHART) report, the major categories of habitat-related activities affecting Central Valley salmonids include: (1) irrigation impoundments and withdrawals, (2) channel modifications and levee maintenance, (3) the presence and operation of hydroelectric dams, (4) flood control and streambank stabilization, and (5) exotic and invasive species introductions and management. All of these activities affect PCEs via their alteration of one or more of the following: stream hydrology, flow and water-level modification, fish passage, geomorphology and sediment transport, temperature, DO levels, nearshore and aquatic vegetation, soils and nutrients, physical habitat structure and complexity, forage, and predation (Spence *et al.* 1996). According to the CHART report (NMFS 2005b), the condition of critical habitat varies throughout the range of the species. Downstream, river and estuarine migration and rearing corridors range in condition from poor to high quality depending on location. Tributary migratory and rearing corridors tended to rate as moderate quality due to threats to adult and juvenile life stages from irrigation diversions, small dams, and water quality. Delta (*i.e.*, estuarine) and mainstem Sacramento and San Joaquin River reaches tended to range from poor to high quality, depending on location. The river reach downstream from Colusa and including the Delta is poor in quality due to impaired hydrologic conditions from dam operations, water quality from urban and agricultural runoff, degraded nearshore and riparian habitat from levee construction and maintenance, and habitat loss and fragmentation.

2. Proposed Critical Habitat for Southern DPS of North American Green Sturgeon

The principal factors for the decline in the Southern DPS of North American green sturgeon are reviewed in the proposed listing notice (April 6, 2005, 70 FR 17386) and status reviews (Adams *et al.* 2002, NMFS 2005a), and primarily consist of: (1) the present or threatened destruction, modification, or curtailment of habitat or range; (2) poor water quality; (3) over-utilization;

(4) increased water temperatures; (5) non-native species; and (6) other natural and manmade factors, including habitat and ecosystem restoration, and global climate change.

NMFS (2005a) concluded that the principle threat to green sturgeon is impassible barriers, primarily Keswick and Shasta Dams on the Sacramento River and Feather River that likely block and prevent access to historic spawning habitat (NMFS 2005a). Spawning habitat may have extended up into the three major branches of the Sacramento River; the Little Sacramento River, the Pit River system, and the McCloud River (NMFS 2005a). In contrast, recent modeling evaluations by Mora (2006) indicate little or no habitat in the Little Sacramento River or the Pit River exists above Shasta Dam; however, a considerable amount of habitat exists above Shasta on the mainstem Sacramento River. Green and white sturgeon adults have been observed periodically in the Feather and Yuba Rivers (USFWS 1995, Beamesderfer *et al.* 2004, McLain 2006), and habitat modeling by Mora (2006) suggests there is sufficient habitat above Oroville Dam. There are no records of larval or juvenile white or green sturgeon; however, there are reports that green sturgeon may reproduce in the Feather River during high flow years (CDFG 2002), but these are unconfirmed.

No green sturgeon have been observed in the San Joaquin River; however, the presence of white sturgeon has been documented (USFWS 1995, Beamesderfer *et al.* 2004), making green sturgeon presence historically likely, as the two species require similar habitat and their ranges overlap in the Sacramento River. Habitat modeling by Mora (2006) also suggests sufficient conditions are present in the San Joaquin River to Friant Dam, and in the Stanislaus, Tuolumne, and Merced Rivers to their respective dams. In addition, the San Joaquin River had the largest spring-run Chinook salmon population in the Central Valley prior to the construction of Friant Dam (Yoshiyama *et al.* 2001) with escapements approaching 500,000 fish. Thus, based on prior spring-run Chinook salmon distribution and habitat use in the San Joaquin River, it is very possible that green sturgeon were extirpated from the San Joaquin River basin in a similar manner to spring-run Chinook salmon. The loss of potential green sturgeon spawning habitat on the San Joaquin River also may have contributed to the overall decline of the Southern DPS of North American green sturgeon.

The potential effects of climate change were discussed in the Chinook salmon and Central Valley steelhead sections and primarily consist of altered ocean temperatures and stream flow patterns in the Central Valley. Changes in Pacific Ocean temperatures can alter predator-prey relationships and affect migratory habitat of the Southern DPS of North American green sturgeon. Increases in rainfall and decreases in snow pack in the Sierra Nevada range will affect cold-water pool storage in reservoirs affecting river temperatures. As a result, the quantity and quality of water that may be available to the Southern DPS of North American green sturgeon will likely significantly decrease.

V. EFFECTS OF THE ACTION

A. Approach to the Assessment

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological and conference opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species. This biological and conference opinion assesses the effects of the proposed action on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, their designated critical habitat, and threatened Southern DPS of North American green sturgeon and their proposed critical habitat.

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02).

NMFS generally approaches "jeopardy" analyses in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of proposed actions on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a sound. Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable exposure to those effects (the extent of temporal and spatial overlap between individuals of the species and the effects of the action). Once we have identified the exposure of the species to the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

To evaluate the effects of the proposed action, NMFS examined proposed construction activities, expected short- and long-term habitat modifications and proposed conservation measures, to identify likely impacts to listed anadromous salmonids within the action area based on the best available information.

The information used in this assessment includes fishery information previously described in the *Status of the Species* and *Environmental Baseline* sections of this biological and conference opinion; studies and accounts of the impacts of riprapping and in-river construction activities on anadromous fish habitat and ecosystem function; and documents prepared in support of the proposed action, including the BA; SAM modeling results; project designs; field reviews; and meetings held between NMFS and the Corps.

B. Assessment

This assessment will consider the nature, duration, and extent of the proposed action relative to the migration timing, behavior, and habitat requirements of Federally listed Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, the Southern DPS of North American green sturgeon and their designated or proposed critical habitat. Specifically, this assessment will consider the potential impacts related to construction and O&M activities, and will use the SAM model (Corps 2004) to assess species response to habitat modifications from proposed bank protection projects over a 50-year period. At this time, the SAM does not apply to green sturgeon. Therefore, long-term effects to green sturgeon, and their proposed critical habitat will be evaluated separately from impacts to anadromous salmonids.

The assessment of effects considers the potential occurrence of Federally listed Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon, relative to the magnitude, timing, frequency, and duration of project activities. Effects of the proposed project on aquatic resources include both short- and long-term impacts. Short-term effects, which are related primarily to construction activities (*i.e.*, increased suspended sediment and turbidity), could last several hours to several weeks. Long-term impacts may last months or years and generally involve physical alteration of the river bank and riparian vegetation adjacent to the water's edge. The project sites are downstream from the spawning habitat of Chinook salmon, steelhead, and the Southern DPS of North American green sturgeon. Therefore, no short- or long-term effects on spawning habitat are expected.

1. Short-term Construction Related Impacts

In-water construction activities, including the placement of rock revetment, could result in direct effects to fish from the placement of rock into occupied habitat during migration periods. The project would result in localized, temporary disturbance of habitat conditions that may alter natural behavior patterns of adult and juvenile fish and cause the injury or death of individuals. These effects may include displacement, or impairment of feeding, migration, or other essential behaviors by adult and juvenile salmon, steelhead, and green sturgeon from noise, suspended sediment, turbidity, and sediment deposition generated during in-water construction activities. Some of these effects could occur in areas downstream of the project sites, because noise and sediment may be propagated downstream.

The extent of construction-related effects is dependant upon the timing of the activities, the timing of fish presence in the action area (Table 5), and their ability to successfully avoid project-related disturbance (Table 6). Peak winter-run Chinook salmon emigration in the action area occurs between November and January, and commonly coincides with initial flow increases of up to 20,000 cfs, which occur from December through February. Juvenile CV spring-run

Chinook salmon and CV steelhead migration can begin as early as November, but similar to winter-run, the peak migration occurs during sustained high flow periods between December and March. Adult Sacramento River winter-run Chinook salmon are expected to be present in the action area from December through May, adult CV spring-run Chinook are expected in the action area from January through July, and adult CV steelhead may be present from September through May.

Table 5. Anadromous fish presence in the Sacramento River during time of Construction

			PL 84-99 Steamboat Slough Levee Repair Construction Work Window			
Species	Life Stage	July	August	September	October	November
Sacramento River Winter-run Chinook Salmon	Adults					
	Juveniles					
Central Valley Spring-run Chinook Salmon	Adults					
	Juveniles					
Central Valley steelhead	Adults					
	Juveniles					
Southern DPS of North American Sturgeon	Adults					
	Juveniles					

Green sturgeon larvae and post-larvae are present in the action area between June and October with highest abundance during June and July (CDFG 2002), and remain in freshwater portions of the Delta for up to 10 months (Kynard *et al.* 2005). In addition, small numbers of juvenile sturgeon less than two years of age have been captured in the action area sporadically in the past (Jeff McLain, NMFS, pers. comm., 2006). Adult green sturgeon holding occurs in the Sacramento River in deep pools for up to six months per year, primarily between March and July (USFWS 2002).

Therefore, based on the known presence of anadromous species in the Sacramento River (Table 5) during the time of construction, it is possible that Adult Southern DPS of North American Sturgeon may be present in the action area at the time of construction, but are unlikely to be affected by the near-shore/on-shore activities due to their benthic nature and preference for deep, mid-channel habitats. Central Valley steelhead may also be present in the action area during the construction work window.

a. Rock Placement into Occupied Aquatic Habitat

(1) Salmon and Steelhead. The placement of rock below the waterline will cause noise and physical disturbance that could displace juvenile and adult fish into adjacent habitats, or crush and injure or kill individuals. The impact of rock being placed in the river disrupts the river flow by producing surface water waves disturbing the water column; resulting in increased turbulence and turbidity. Migrating juveniles react to this situation by suddenly dispersing in random directions. This displacement can lead them into predator habitat where they can be targeted, and injured and killed by opportunistic predators taking advantage of juvenile behavioural changes. Carlson *et al.* (2001) observed this behaviour occurring in response to routine channel maintenance activities in the Columbia River. Some of the fish that did not immediately recover from the disorientation of turbidity and noise from channel dredges and pile driving swam directly into the point of contact with predators. Feist *et al.* (1992) found that noise from pile driving activities in the Puget Sound affected the general behavior of juveniles by temporarily displacing them from construction areas. Nearly twice as many fish were observed at construction sites on non-pile driving days compared to days when pile driving occurred.

Biological studies conducted at GCID also support that predation may be higher in areas where juveniles are disoriented by turbulent flows or are involuntarily routed into high-quality predator habitat or past areas with higher predator densities (Vogel 2004). Behavioural observations of predator and salmon interactions at GCID also indicated that predators responded quickly to the release of fish during the biological tests and preyed on fish soon after they were released into the water, even when the release locations were periodically changed (David Vogel, Natural Resource Scientists, pers. comm. 2006). This is a strong indication that predators quickly respond to changes in natural juvenile salmonid behavioural responses to disturbance.

NMFS was unable to find any scientific evidence that fish may be injured or killed by crushing from rock placement. Regardless, many juvenile fish are small, relatively slow swimmers, typically found in the upper two feet of the water column, and oriented to nearshore habitat. Larger fish, including adults and smolts probably would respond by quickly swimming away from the placement site, and would escape injury or death. Fry-sized fish (those that are less than 50mm) that are directly in the path of rock placement may be less likely to avoid the impact. Therefore, the placement of large quantities of rock into this habitat has the potential to crush and injure or kill fry-sized salmon and steelhead. However, the best available outmigration data throughout the Sacramento River, indicate that fry-size listed salmon or steelhead are unlikely to be present in the action area during the construction period, unless flood conditions wash fish downstream. In such a case, the Corps would suspend construction until flows subsided. The only area where fry-sized fish are likely to be present during construction is in region 3. Regardless of river flow, fry-sized winter-run Chinook salmon are consistently trapped by CDFG rotary screw traps (RST) at GCID from August through December. RST captures are low in August and peak from October through November. NMFS expects that the presence of these small fish in region 3, during the placement of rock into the Sacramento River, may crush and kill some winter-run Chinook salmon.

The sound generated by the operation of heavy equipment such as crane mounted barges and other construction activities may temporarily affect the behavior of migrating adult salmonids, possibly causing migration delays. However, construction activities are not likely to injure or kill adult winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead because of their crepuscular migration behavior, and because these fish tend to utilize mid-channel, deep water habitats. Construction will be restricted to the channel edge, and will include implementation of avoidance and minimization measures that will prevent impacts to the migrational behavior of listed species.

(2) Green Sturgeon. Green sturgeon are likely to be present in the action area during construction. However, NMFS does not expect that green sturgeon will be directly affected by rock placement along the bank of the river because green sturgeon are primarily benthic, and their presence along the shoreline is not expected to be common. Therefore, adverse effects including injury or death from rock placement are not expected.

b. Sediment and Turbidity

Rock placement and nearshore construction will disturb soils and the riverbed and result in increased erosion, siltation, and sedimentation. Short-term increases in turbidity and suspended sediment may disrupt feeding activities of fish or result in temporary displacement from preferred habitats.

(1) Salmon and Steelhead. Numerous studies show that suspended sediment and turbidity levels moderately elevated above natural background values can result in non-lethal detrimental effects to salmonids. Suspended sediment affects salmonids by decreasing reproductive success, reducing feeding success and growth, causing avoidance of rearing habitats, and disrupting migration cues (Bash *et al.* 2001). Sigler *et al.* (1984) in Bjornn and Reiser (1991) found that prolonged turbidity between 25 and 50 Nephelometric Turbidity Unit (NTUs) reduced growth of juvenile coho salmon and steelhead. Macdonald *et al.* (1991) found that the ability of salmon to find and capture food is impaired at turbidities from 25 to 70 NTUs. Bisson and Bilby (1982) reported that juvenile coho salmon avoid turbidities exceeding 70 NTUs. Increased sediment delivery can also fill interstitial substrate spaces and reduce cover for juvenile fish (Platts *et. al.* 1979) and abundance and availability of aquatic invertebrates for food (Bjornn and Reiser 1991). We expect turbidity to affect Chinook salmon and steelhead in much the same way that it affects other salmonids, because of similar physiological and life history requirements between species.

Newcombe and Jensen (1996) found that impacts on fish populations exposed to episodes of high suspended sediment may vary depending on the circumstance of the event. They also concluded that wild fish may be less susceptible to direct and indirect effects of localized suspended sediment and turbidity increases because they are free to move elsewhere in the system and avoid sediment related effects. They emphasize that the severity of effects on salmonids depends not only on sediment concentration, but also on duration of exposure and the sensitivity of the affected life stage.

Suspended sediment from construction activities would increase turbidity at the project site and could continue downstream. Although Chinook salmon and steelhead, are highly migratory and capable of moving freely throughout the action area, an increase in turbidity may injure fish by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, and migrating. Injury is caused when disrupting these behaviors increases the likelihood that individual fish will face increased competition for food and space, and experience reduced growth rates or possibly weight loss. Project-related turbidity increases may also affect the sheltering abilities of some fish and may decrease their likelihood of survival by increasing their susceptibility to predation.

Construction activities are expected to result in periodic turbidity levels that exceed 25 to 75 NTUs, and thus capable of affecting normal feeding and sheltering behavior. Based on observations during similar construction activities in the Sacramento River, turbidity plumes are not expected to extend across the Sacramento River, but rather the plume is expected to extend downstream from the site along the side of the channel. Turbidity plumes will occur during in-water construction. At a maximum, these plumes are expected to be as wide as 100 feet, and extend downstream for up to 1,000 feet. Most plumes extend into the channel approximately 10 to 15 feet, and downstream less than 200 feet. Once construction stops, water quality is expected to return to background levels within hours. Adherence to erosion control measures and BMPs such as use of silt fences, straw bales and straw wattles will minimize the amount of project-related sediment and minimize the potential for post-construction turbidity changes.

(2) Green Sturgeon. Green sturgeon are expected to be present in the action area during construction, and therefore may be exposed and affected by short-term increases in turbidity and suspended sediment if these increases disrupt feeding and migratory behavior activities of post-larvae, juvenile, and adult fish. Turbidity and sedimentation events are not expected to affect visual feeding success of green sturgeon, as they are not believed to rely heavily on visual cues (Sillman *et al.* 2005). Instead, olfaction appears to be a key feeding mechanism as green sturgeon are frequently found in highly turbid environments. In addition, green sturgeon are primarily benthic, and their presence along the shoreline is not expected to be common. Therefore, adverse effects including injury or death from temporary increases in sediment and turbidity are not expected.

c.. *Other Water Quality Effects*

Toxic substances used at construction sites, including gasoline, lubricants, and other petroleum-based products could enter the Sacramento River as a result of spills or leakage from machinery or storage containers and injure or kill listed salmon, steelhead, and green sturgeon. These substances can kill aquatic organisms through exposure to lethal concentrations or exposure to non-lethal levels that cause physiological stress and increased susceptibility to other sources of mortality. Petroleum products also tend to form oily films on the water surface that can reduce DO levels available to aquatic organisms.

d. *Summary of Construction-related Effects*

(1) *Salmon and Steelhead.* NMFS expects that relatively low numbers of anadromous salmonids will be present in the action area during construction activities because the construction periods have been scheduled to minimize overlap with primary migration periods.

Those fish that are exposed to these activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise, physical disturbance, and water quality changes that may cause injury or death by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors, and affecting sheltering abilities. Some juvenile fish may be crushed, and killed or injured during rock placement, especially fry-sized winter-run Chinook salmon that may be present. Others may be displaced from natural shelter and preyed upon by piscivorous fish. Although construction will occur during peak migration periods, relatively few juvenile fish are expected to be injured or killed by in-river construction activities because most fish are expected to avoid construction activities due to their predominately crepuscular migration behaviors. The implementation of BMPs and other conservation measures also will minimize impacts to the aquatic environment and reduce project-related effects to fish. In addition, and with the exception of the occurrence of winter-run Chinook salmon in the area, peak migration events correspond with periods of high river flows, when in-river construction activities are likely to be suspended. Furthermore, only one cohort, or emigrating year class, out of perhaps four to five within each salmon and steelhead population will be affected. Therefore, NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance, and not likely to result in any long-term, negative population trends. Adults should not be injured because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance.

(2) ***Green Sturgeon.*** Adult green sturgeon move upstream through the project sites between March and July. Long-term changes in nearshore habitat are expected to have negligible effects on adults because adult sturgeon use deep, mid-channel habitat during migration. The long-term effects of the proposed project related to North American green sturgeon adults would primarily be related to the alteration of the Sacramento River below the waterline as migrating and holding adults utilize benthic habitat. Therefore, NMFS expects that adult fish are not likely to be injured or killed as a result of the project since most fish are expected to migrate through deeper mid-channel pathways and will avoid direct exposure to project sites.

e. *Construction-related effects to Critical Habitat*

Construction activities will alter the site-scale physical characteristics of the PCEs of salmon and steelhead critical habitat, including elements of freshwater and estuarine rearing and migration habitat. These effects are discussed in detail below in *Section 2, Long Term Impacts.*

Table 6. Species/Critical Habitat Response to the Action

Type of Disturbance	Possible effects of Disturbance	Immediate short term effects Construction Phase (*dates, times)	Fish Present/Likely to Effect	Short Term Effects (1 – 3 years)	Fish Present/Likely to Effect	Long Term Effects (4 – 50 years)	Fish Present/Likely to Effect
1. Turbidity	1. Siltation of spawning gravels 2. Avoidance	1. Possible, but unlikely due to location of action area to available spawning areas. 2. Very likely to occur if fish are present	Not Likely - due to elevated summer temperatures in action area	N/A	1. Juvenile-Green sturgeon 2. Adult – Green sturgeon	N/A	N/A
2a. Rock Placement *Spawning Gravel*	1. Reduction in available spawning gravel recruitment	1. Unlikely contributor due to low amount of available spawning area downstream of action area.	Not Likely - due to elevated summer temperatures in action area	N/A	N/A	N/A	N/A
2b. Rock Placement *Vegetation Removal*	1. Impede plant growth through thick rock at waterline, which results in vegetation being further back from the shoreline, thus reducing the contribution of allochthonous food resources for aquatic invertebrates	1. Immediate Loss of some of the vegetation component. 2. Immediate Loss of allochthonous food resources for aquatic invertebrates	Not Likely - due to elevated summer temperatures in action area	1. Deficits for 1 – 3 years following the removal of any existing riparian vegetation. 2. Deficits for 1 -3 years following the removal of existing riparian vegetation and loss of allochthonous food contributions.	Juveniles – Fall-, Winter-, Spring-run, Chinook salmon and steelhead	1. Positive benefits for 4 – 50 years (life of project) as planted vegetation reaches maturity	Juveniles – Fall, Winter, Spring
2c. Rock Placement *Smooth hydraulically efficient surface.*	1. Increased water velocities near shoreline 2. Increased erosional processes downstream of action area.	1. Immediate increase in near shoreline water velocities resulting in immediate loss of winter/spring high flow events. 2. Immediate increase in downstream erosional processes during winter/spring high flow events.	Not Likely - due to elevated summer temperatures in action area	1. For lifetime of project or until deposition and vegetation becomes established. 2. For lifetime of project or until deposition and vegetation becomes established	Juvenile – Green sturgeon and steelhead	1. If conditions allow, sedimentation should have occurred allowing for both natural vegetation recruitment which will reduce the near shoreline velocities 2. and reduced the erosional processes downstream	Juveniles – Fall, Winter, Spring
2d. Rock Placement *Halting Natural erosional processes*	1. Reduced recruitment of spawning gravel for salmonids 2. Halts new accretion of point bars and other depositions where new riparian vegetation can colonize. 3. Arrest meander migration which over time, reduces habitat renewal, diversity and complexity.	1. Immediate reduction of future recruitment of spawning gravel 2. Immediate reduction of materials available to form point bars and other depositions where new riparian vegetation can colonize. 3. Immediate and permanent reduction in ability of river to migrate.	Not Likely - due to elevated summer temperatures in action area	1. For lifetime of project or until sedimentation deposition and vegetation becomes established. 2. For lifetime of project or until sedimentation deposition and vegetation becomes established 3. Permanent for lifetime of project	All stages of life cycle of Chinook salmon, steelhead, and green sturgeon	1. For lifetime of project or until sedimentation deposition and vegetation becomes established. 2. For lifetime of project or until sedimentation deposition and vegetation becomes established 3. Permanent for lifetime of project	Juveniles – Fall, Winter, Spring
2e. Rock Placement *Increased substrate size along shore line*	1. Change in Predator/Prey relationships	1. Immediate available habitat for predator species with larger rock sizes along the bank.	Not Likely - due to elevated summer temperatures in action area	1. For lifetime of project or until sedimentation deposition and vegetation becomes established.	Juveniles – Fall-, Winter-, Spring-run Chinook salmon	1. For lifetime of project or until sedimentation deposition and vegetation becomes established.	Juveniles – Fall, Winter, Spring

2. Long-Term effects

a. About the SAM

The SAM was used to quantify the responses of listed fish species to with-project conditions over a 30-year project period and compared these responses to the species responses under without-project (existing) conditions. The assessment followed the general steps outlined in the *SAM Final Review Draft and Users Manual* (Stillwater Sciences and Dean Ryan Consultants & Designers 2004, 2006). Computations were performed using the Electronic Calculation Template provided by Stillwater Sciences.

The SAM was designed to address a number of limitations associated with previous habitat assessment approaches and provide a tool to systematically evaluate the impacts and compensation requirements of bank protection projects based on the needs of listed fish species. A major advantage of the SAM is that it integrates species life history and flow-related variability in habitat quality and availability to generate species responses to project actions over time. Species responses represent an index of a species growth and survival based on a 30-day exposure to post project conditions in a variety of seasons and life-history stages, over the life of the project. Negative responses (SAM deficits), are indicators of reduced growth and survival conditions relative to baseline conditions, and positive responses, are indications of improved growth and survival conditions.

The model is capable of projecting how without-project conditions would change over time. However, the modeling for these projects compared the with-project conditions to a static existing baseline because it simplifies the interpretation of modeling results and because, based on site evaluations conducted by NMFS, the baseline conditions probably would decline due to the limited amount of remaining high quality habitat. Also, given the critical state of the existing sites, the without-project scenario is likely to include emergency flood fighting that would result in substantial habitat degradation.

The SAM quantifies habitat values in terms of bank line- or area-weighted species responses that are calculated by combining habitat quality (fish response indices) with quantity (bank length or wetted area) for each season, target year, and relevant species and life stage. The SAM (Stillwater Sciences, 2004) employs six habitat variables to characterize nearshore and floodplain habitats of listed fish species.

(1) Bank slope. This is the average bank slope along each average seasonal water surface elevation. Bank slope is an indicator of shallow-water habitat availability, which is important for juveniles for feeding, rearing, and refugia from high flows and predators. The relationship of bank slope to fish response is related to how variations in fish size and foraging strategies affect growth potential and expose various species and life stages to predation risk. For fry and smolts of each species, shallow water near the bank is considered to be high value because it provides refuge from predators and low velocity feeding and rearing habitat (Power 1987, Schlosser 1991, and Waite and Barnhart 1992). Smaller fish can avoid predation by piscivorous fish to some degree by selecting shallower water. Although larger fish (*i.e.*, smolts) typically use deeper water habitats, it is assumed that predation risk also increases. Adult life stages are not affected by the same predation as juveniles and tend to utilize deep, mid-channel habitat as migratory corridors. Therefore, adults are not expected to be sensitive to changes in bank slope.

(2) Floodplain availability. This is the ratio of wetted channel and floodplain area during the2-year flood to the wetted channel area during average winter and spring flows. Floodplain availability is used as an indicator of seasonally flooded shallow-water habitat availability, which is important for juveniles for feeding, rearing, and refugia from high flows and predators. Use of seasonally inundated flooded habitat is generally considered to increase growth of juvenile salmonids due to greater access to areas with high invertebrate productivity from flooded terrestrial matter (Sommer *et al.* 2001). Predation risk in seasonally flooded areas is expected to be less in seasonally inundated areas with large amounts of hiding cover and a lack of piscivorous fish. Adult life stages tend to utilize deep, mid-channel habitat and are not expected to be sensitive to changes in floodplain availability.

(3) Floodplain variability. This was estimated from aerial photographs and engineering cross-sections of the project sites. Based on these analyses, there are no significant changes in the wetted width of the river expected under the with-project conditions.

(4) Bank substrate size. This is measured as the median particle diameter of the bank (*i.e.*, D50) immediately below (*i.e.*, 0 to 3 feet) each average seasonal water surface elevation. Bank substrate size is used as an indicator of juvenile refugia from predators, but also as an indicator of suitable predator habitat. Increased predator density has been observed at riprapped sites relative to natural banks at studies in the Sacramento River and the Delta (Michny and Deibel 1986, Michny 1989). Substrate size also is used as an indicator of food availability. The effects of substrate size on mortality risk are expected to be greatest at small grain sizes due to a lack of cover from avian and piscivorous fish predation. Predation risk is lower at intermediate sizes close to the size of the affected life stage because small interstitial spaces offer cover from predators. Predation risk is highest when grain sizes exceed the length of the affected life stage, because interstitial spaces are capable of providing effective cover for piscivorous fish species. Adult life stages tend to utilize deep, mid-channel habitat and are not expected to be sensitive to changes in bank substrate size.

(5) Instream structure. This is measured as the percent of shoreline coverage of IWM along each average seasonal water surface elevation. The value of instream structure to salmonids has been directly demonstrated by various studies. Instream structure is an indicator of juvenile refugia from predators (Michny and Hampton 1984, Michny and Deitel 1986). Instream structure is used as an indicator of food availability, feeding station availability, and as cover and resting habitat for adults. Instream structure provides high quality resting areas for adults and juveniles, cover from predation, and substrate for macroinvertebrate production (USFWS 2000, Lassettre and Harris 2001, Piegay 2002).

(6) Aquatic and submerged terrestrial vegetation. This is measured as the percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation. Aquatic vegetation is used as an indicator of juvenile refugia from predators, and food availability. Rearing success is strongly affected by aquatic vegetation (Corps 2004). Biological response to aquatic vegetation is influenced by the potential for food production and cover to sensitive life stages. Because salmonid fry and juveniles are commonly found along shore in flooded vegetation (Cannon and Kennedy 2003) increases in aquatic and submerged terrestrial vegetation is expected to result in a positive salmonid response (*i.e.*, increased growth, reduced risk of predation). Adult salmonids are not expected to be sensitive to changes in aquatic or submerged terrestrial vegetation.

(7). Overhanging shade. This is measured as the percent of the shoreline coverage of shade along each average seasonal water surface elevation. The value of overhanging shade is an indicator of juvenile refugia from predators, and food availability. Numerous studies have shown the importance of overhanging shade to salmonids. Shade provides overhead cover and allochthonous input of leaf litter and insects which provide food for juveniles. Michny and Hampton (1984), and Michny and Deibel (1986) juvenile salmonid abundance was highest in reaches of the Sacramento River with shaded riparian cover.

As with many models, SAM modeling is based on many assumptions about species behavior and response to habitat changes. There also are untested assumptions regarding the response of physical project elements to river flows and other unpredictable environmental events. Therefore, there is a considerable amount of uncertainty regarding the results. To account for some of the uncertainty, the Corps, NMFS, USFWS, and scientists from Stillwater Sciences discussed and agreed upon conservative model input variables that tend to generate worst-case scenarios based on conservative estimates of habitat modification and improvement overtime. The model itself accounts for some of the uncertainty by generating results at four different average water surface elevations. To account for site diversity, model input values are not measured only at discrete average flow elevations, but within three feet of these elevations. Although the model focuses on a discrete average water surface elevation, seasonal variability of average flows is accounted for in the project designs because project features, and conservation measures (*i.e.*, benches, vegetation) are placed at variable elevations. Long-term comprehensive monitoring will measure the success of model results by evaluating habitat evolution and fish habitat use. The design of monitoring studies, including frequency, duration, and location, is currently under development.

Further support for expectations regarding the physical response to habitat conditions over time is supplied by the monitoring results for similar projects in the American and Sacramento Rivers. Riparian and SRA monitoring at eight bank protection or revegetation projects along the American River, demonstrated that riparian goals for tree and shrub width, height, cover, and shoreline cover were met or exceeded at all sites (Ross 2006).

b. SAM Results for Chinook salmon and steelhead

The SAM results showed positive results in all life stages for salmon and steelhead. Specifically, the SAM results showed long-term (*i.e.*, 1 to 10 year) gains in the summer, fall, and spring habitat values for juvenile rearing and smolt life stages. By comparing the existing and post construction condition, the migratory corridor would improve. The bank slope and floodplain availability for the repair sites would not change. The willow pole cuttings along the bank shoreline would increase shaded riverine habitat since the migratory corridor in the area is highly degraded. As the willows grow, the overhanging and terrestrial vegetation would improve. A temporal loss of 1-3 years could occur given the survival rate for the willows are 30 percent. The tule plantings along Steamboat Slough would be an increase of aquatic vegetation and increase available rearing habitat for juvenile Chinook salmon and steelhead during their out-migration. The addition of four-inch minus rocks placed on top of the larger riprap will reduce the potential of predator species utilizing the crevices of the rocks as their habitat. Thus, NMFS expects that the project would have no negative affects to juvenile salmon and steelhead. In addition, NMFS expects that his project will have little long-term effect on adult migration. Adult upstream-migrations occur mid-channel, and the changes to near-shore habitats resultiing from this project are not expected to change the hydrology of the mid-channel portion of the river.

c. SAM results for Southern DPS of North American Green Sturgeon

Although it is believed that larvae and post-larvae as well as juveniles primarily are benthic (with the exception of the post-larvae nocturnal swim-up believed to be a dispersal mechanism), the removal or reduction of riparian vegetation and IWM likely impacts potential prey items and species interactions that green sturgeon would experience while rearing and migrating. These changes are minimized considerably in the project design and the effects of this riparian and IWM removal or reduction would decrease through time as a result of the proposed projects conservation measures.

In the absence of modeled response data for green sturgeon, NMFS expects responses to long-term, project-related habitat conditions to be similar to juvenile salmonids. However, because green sturgeon are not as near-shore oriented as juvenile Chinook salmon, the relative proportion of the green sturgeon population that will be affected by these conditions should be low.

3. Impacts of Project Monitoring

The monitoring plan will involve photo documentation and point estimates of substrate size, riparian vegetation, and other physical project elements. Direct sampling of juvenile anadromous fish is not proposed. This monitoring is not expected to have any effect on Federally listed fish or designated or proposed critical habitat.

4. Interrelated or Interdependent Actions

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). NMFS considered concurrent, ongoing implementation of additional SRFCP repair projects to determine if they could be considered interrelated or interdependent actions to the proposed action. NMFS determined that these other levee repair projects are not interrelated because there is no single authority or program that binds them together or interdependent because they would occur regardless of the proposed action.

C. Summary of Effects

NMFS expects that a relatively small but unknown number of juvenile steelhead and green sturgeon will be present in the action area during construction activities. Only those fish that are holding adjacent to or migrating past a project site are likely to be exposed or affected. Those fish that are exposed to the effects of construction activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise, physical disturbance, and water quality changes that may cause injury or death by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors, and affecting sheltering abilities. Some juvenile fish may be crushed, and killed or injured during rock placement. Others may be displaced from natural shelter and preyed upon by piscivorous fish. Relatively few juvenile fish are expected to be injured or killed by in-river construction activities because most fish are expected to avoid construction activities due to their predominately crepuscular migration behaviors. The implementation of BMPs and other conservation measures also will minimize impacts to the aquatic environment and reduce project-related effects to fish. Furthermore, only one cohort, or emigrating year class, out of perhaps four to five within each salmon and steelhead population will be affected. Therefore, NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance, and not likely to result in any long-term, negative population trends. Adults should not be injured because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance.

Green sturgeon may be present holding and spawning and their spawning habitat and spawning behavior may be affected if rock is placed into deepwater habitats in the upper regions of the action area. There are eight projects located in these reaches, and none one of them is being constructed within the known spawning habitat of the species, the number of fish likely to be affected is low and limited to the project length.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological and conference opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by State or local agencies do not require Federal permits. These types of actions and illegal placement of riprap and other bank stabilization techniques are common throughout the action area. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic habitats to simplified habitats that affect salmonids in ways similar to, but more intensely (due to a lack of restoration and conservation measures) than the adverse effects associated with the proposed action. Reasonably certain cumulative effects include any continuing or future non-Federal water diversions. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs along the lower Sacramento River contribute to these cumulative effects. These diversions also include municipal and industrial uses as well as water for power plants. Water diversions affect salmonids and sturgeon by entraining, and injuring or killing adult and juvenile fish.

Additional cumulative effects may result from the discharge of point and non-point source chemical contaminants. These contaminants include selenium and numerous pesticides and herbicides associated with discharges from agricultural and urban areas. Contaminants may injure or kill salmonids and green sturgeon by affecting food availability, growth rate, susceptibility to disease, or other physiological processes necessary for survival.

VII. INTEGRATION AND SYNTHESIS

This section considers the *Effects of the Action*, and the *Integration and Synthesis* section of the programmatic biological opinion, which includes analysis of the *Environmental Baseline, Cumulative Effects*, and the effects of the programmatic action.

A. Impacts of the Proposed Action on Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, Central Valley Steelhead

The *Environmental Baseline* section of the biological opinion describe how recent evaluations of the viability of Central Valley salmonids found that independent populations of Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon appear to be generally viable because they meet several viability criteria including population size, growth, and risk from hatchery strays. The viability of the ESU to which these populations belong appears low to moderate, as the ESU remains vulnerable to extirpation due to their small-scale distribution of independent populations and high likelihood of being affected by a significant catastrophic event. Lindley *et al.* (2007) were not able to determine the viability of existing steelhead populations, but believe that the DPS has a moderate to high risk of extirpation since most of the historic habitat is inaccessible due to dams, and because the anadromous life-history strategy is being replaced by residency. The continued existence of green sturgeon in the Sacramento River and the observation of sturgeon in the Feather and Yuba Rivers indicate that the population is viable and faces a low to moderate risk of extinction. The largest threats to the viability of the ESUs and DPS' are related to loss of access to historic habitats, and the existence of few independent populations, which places the species at risk of extirpation from catastrophic events.

The *Cumulative Effects* section of the biological opinion described how future State, tribal, local, or private actions that are reasonably certain to occur in the action area include non-Federal riprap projects, continuing or future non-Federal water diversions, the discharge of point and non-point source chemical contaminant discharges, and climate change. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of the rearing and migratory corridors.

NMFS expects that the proposed action will result in adverse short-term, construction-related impacts to the species and their critical habitat that will injure and/or kill Federally listed

Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. Construction-related effects are expected to only affect juveniles. Juveniles are expected to be affected because of their small size, reliance on nearshore aquatic habitat, and vulnerability to factors that injure or kill them, or otherwise affect their growth and survival, such as noise or crushing of fish from rock placement and barge activity, changes in water quality that temporarily modify their natural behavior and may expose them to increased predation.

Construction impacts to juveniles, occurring for a distance of approximately 7,500 lf of aquatic habitat along the banks of the Sacramento River and Steamboat Slough, are expected to impact juveniles from August 2009 through October 2009. The implementation of BMPs and other on-site measures also will minimize impacts to the aquatic environment and reduce project-related effects to fish. Furthermore, only one cohort, or emigrating year class, out of perhaps four to five within each population will be affected. Therefore, NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance, and not likely to result in any long-term, negative population trends. Adults should not be injured because their size, preference for deep water, and crepuscular migratory behavior enable them to avoid temporary, nearshore disturbance.

SAM-modeled habitat deficits may cause injury and death of individuals at all sites from reduced growth conditions and increased predation, for 1 to 3 years. Long-term effects as modeled by the SAM are expected to result in reduced growth and survival conditions for juvenile and smolt Chinook salmon and steelhead at all seasonal water surface elevations for 1 to 3 years and substantial gains in value from 5 to 10 years. Deficits at summer and fall flow conditions are greater that those at the winter and spring flows. The modeled summer and fall habitat deficits are expected to affect relatively few fish and will not be limiting to Chinook salmon or steelhead populations, since the majority of adult migration and juvenile rearing and emigration within the action area does not occur during average fall flow conditions. Instead, a significant majority of Chinook salmon and steelhead adult migration and juvenile rearing and emigration occurs during periods of higher flow that are more accurately represented by conditions at average winter and spring water surface elevations, where the habitat deficits are less, and the baseline conditions are reached or exceeded more quickly (*i.e.*, 5 to 10 years versus 10 to 15 years for fall and summer elevations).

B. Impacts of the Proposed Action on the Southern Distinct Population Segment of North American Green Sturgeon

NMFS also expects the action to adversely affect the Federally listed Southern DPS of North American green sturgeon. Adverse effects to these fish are expected to be limited to migrating and rearing larvae, post-larvae, juveniles and holding adults. Juveniles are expected to be affected most significantly because of their small size, reliance on aquatic food supply (allochthonous food production), and vulnerability to factors that affect their feeding success and survival. Construction activities will cause disruptions from increased noise, turbidity, and in water disturbance that may injure or kill larvae, post-larvae, and juveniles by causing reduced growth and survival as well as increased susceptibility to predation. Adverse affects to adults are primarily limited to the alteration of habitat below the waterline affecting their prey base and feeding success. As is the case for salmonids, the impacts to proposed critical habitat that are expected at certain sites will result in short-term reductions in the value of some features while eventually resulting in substantial long-term gains in conservation value of nearshore and riparian features offering benefits to larvae, post-larvae, juvenile, and adult Southern DPS of North American green sturgeon.

C. Impacts of the Proposed Action on the Survival and Recovery of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead

The adverse effects associated with the implementation of the proposed project, when analyzed within the context of the current condition of these listed species and the expected future cumulative effects within the action area, are not expected to appreciably reduce the likelihood of survival and recovery of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead. This is largely due to the fact that the project will compensate for temporary and permanent habitat losses of habitat through implementation of on-site conservation measures. Most construction-related impacts will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or juvenile fish from migrating to downstream rearing areas. The number of individuals actually injured or killed by construction is expected to be small because only fish that are present during the time of construction are expected to be affected. Similarly, the number of fish that will be injured or killed as a result of short-and long-term habitat impacts, as indexed by the SAM will be low because the primary loss of habitat condition and function is limited to the low-flow fall water surface elevations, while the majority of juvenile fish are expected to be present during winter and spring months, when seasonal water elevations are higher, and integrated conservation measures such as riparian vegetation and overhanging shade are available to the species. Although Federally listed anadromous fish may be present in the action area during the summer and fall months, abundance is relatively low compared to the number of fish that are present during winter months.

Although some injury or death to individual fish is expected from construction activities and short- and long-term habitat modification, successful implementation of all conservation measures is expected to improve migration and rearing conditions, and the growth and survival of juvenile salmon and steelhead during peak rearing and migration periods by protecting, restoring, and in many cases, increasing the amount of flooded shallow water habitat and SRA habitat throughout the action area. Because of this, the proposed action is not expected to reduce the likelihood of survival and recovery of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

D. Impacts of the Proposed Action on the Survival and Recovery of the Southern Distinct Population Segment of North American Green Sturgeon

The adverse effects to the Southern DPS of North American green sturgeon, when analyzed within the context of the current condition of this threatened species and the expected future cumulative effects within the action area, are not expected to affect the overall survival and recovery of the DPS. Construction-related impacts will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or larvae, post-larvae, and juvenile fish from rearing or migrating to downstream rearing areas. The number of individuals actually injured or killed is expected to be undetectable and negligible and, population-level impacts are not anticipated. Implementation of the conservation measures will ensure that long-term impacts associated with bank protection projects will be compensated in a way that prevents incremental habitat fragmentation and reductions of the conservation value of aquatic habitat to anadromous fish within the action area. Because of this, the proposed action is not expected to reduce the likelihood of survival and recovery of the Southern DPS of North American green sturgeon.

E. Impacts of the Proposed Action on Designated and Proposed Critical Habitat

Impacts to the designated critical habitat of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead include the short- and long-term modification of approximately 7,500 lf of nearshore aquatic and riparian areas that are designated critical habitat. PCEs at the 18 sites include riverine areas for rearing and migration. NMFS CHART (2005b) described existing PCEs within the action area as degraded, with isolated fragments of high quality habitat. In spite of the degraded condition, the CHART report rated the conservation value of the action area as high because it is used as a rearing and migration corridor for all populations of winter-run Chinook salmon and Central Valley spring-run Chinook salmon, and by the largest populations of Central Valley steelhead.

Impacts to PCEs will last for 1 to 5 years, and after 5 years NMFS expects continued improvements leading to substantial gains in habitat quality. The primary project-related impacts to PCEs are at fall and summer low-flow conditions and result from loss or modification of riparian vegetation, shallow-water habitat, and the increase in bank substrate size. These losses and modifications affect juvenile rearing and migration PCEs by reducing instream cover and refuge areas and food production. The action area serves primarily as a migration corridor. Freshwater migration corridors must function sufficiently to provide adequate passage; project effects are not expected to reduce passage conditions based on the length of time individual juvenile salmonids will be exposed to the reduced quality and availability of refuge areas as they transit through the action area. Thus, NMFS does not expect the 1 to 3 year reduction in the quality and availability of refuge areas in these reaches of the river to be limiting to the anadromous populations in the system. From year 4 through 50, the PCEs will improve as vegetation matures and extends over the shoreline. The improved conditions are expected to improve the growth and survival conditions for juvenile fish. Therefore, we do not expect project-related impacts to reduce the conservation value of designated critical habitat of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

The PCE's of green sturgeon proposed critical habitat are not expected to be significantly impacted by the proposed project. Green sturgeon are not as dependant on near-shore habitat features as juvenile Chinook salmon. Thus, the projected short-term reductions in near-shore habitat features such as SRA and shallow water with flooded vegetation are not expected to result in measurable reductions in the conservation value of green sturgeon proposed critical habitat within the action area.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the current status of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon,, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the Steamboat Slough PL 84-99 Levee Repairs, as proposed, are not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or the Southern DPS of North American green sturgeon, and are not likely to destroy or adversely modify the designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead,.

After reviewing the best available scientific and commercial information, the current status of the Southern DPS of North American green sturgeon proposed critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' conference opinion that the Steamboat Slough PL 84-99 erosion repairs, as proposed, are not likely to destroy or adversely modify proposed critical habitat for the Southern DPS of North American green sturgeon.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibits the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The listing of the Southern DPS of North American green sturgeon became effective on July 7, 2006, and some or all of the ESA section 9(a) prohibitions against take will become effective upon the future issuance of protective regulations under section 4(d). Because there are no section 9(a) prohibitions at this time, the incidental take statement, as it pertains to the Southern DPS of North American green sturgeon, does not become effective until the issuance of a final 4(d) regulation, as appropriate.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any contract, grant or permit, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps: (1) fails to assume and implement the terms and conditions, or (2) fails to require the contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement [50 CFR 402.14(i)(3)].

A. Amount and Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon from impacts related to construction of the Steamboat Slough Levee Repair project as a result of reductions in the quality or quantity of their habitat. Take is expected to be limited to rearing juveniles.

NMFS cannot, using the best available information, quantify the anticipated incidental take of individual Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon because of the variability and uncertainty associated with the annual population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use within the project area. However, it is possible to designate ecological surrogates for the extent of take anticipated to be caused by the project, and to monitor those surrogates to determine the level of take that is occurring. The most appropriate ecological surrogates for the extent of take caused by the project are the physical and temporal extent of turbidity caused by construction of the project and the period of time that habitat values will be reduced by construction impacts, as represented by the SAM modeling results.

1. The analysis of the effects of the proposed project anticipates that take in the form of injury and death from predation will result from construction-related turbidity that will extend up to 100 feet from the shoreline, and up to 1,000 feet downstream, along 7,500 linear feet of construction areas along the shore line Steamboat Slough and the Sacramento River.

2. The analysis of the effects of the proposed project anticipates that take in the form of harm, injury, and death of rearing and migrating juvenile Chinook salmon, steelhead, and green sturgeon will result from a reduction in the quality and quantity of nearshore habitat features. These reductions in habitat value are expected to last for no more than 5 years before recovering to, or exceeding, the current level of habitat value.

Anticipated incidental take may be exceeded if project activities exceed the criteria described above, if the project is not implemented as described in the BA prepared for this project, or if the project is not implemented in compliance with the terms and conditions of this incidental take statement.

B. Effect of the Take

NMFS has determined that the amount and extent of take described above is not likely to jeopardize Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or the Southern DPS of North American green sturgeon. The effect of this action in the proposed project areas will consist of fish behavior modification, temporary loss of habitat value, and potential death or injury of juvenile Sacramento River winter-run Chinook salmon, Central Valley steelhead, and Central Valley spring-run Chinook salmon, and the Southern DPS of North American green sturgeon.

C. Reasonable and Prudent Measures

NMFS has determined that the following reasonable and prudent measure (RPM) is necessary and appropriate to minimize the incidental take of listed anadromous salmonids and green sturgeon.

> Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

D. Terms and Conditions

Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

1. All existing vegetation greater than 4 inches in diameter is to be protected and left in place to the greatest extent possible.

2. The Corps shall monitor all vegetation planted yearly and provide a survivability report to NMFS by December 31 of each year for three years.

3. Reports shall be submitted to:
   Sacramento Area Office
   National Marine Fisheries Service
   650 Capitol Mall, Suite 8-300
   Sacramento California 95814-4706
   Phone: (916) 930-3600
   FAX: (916) 930-3629

IX. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. These conservation recommendations include discretionary measures that the Corps can implement to further the conservation of listed species and critical habitat, and further the development of information on the conservation of these species.

1. The Corps should ensure that future maintenance actions that repair the bank protection structure fully replace riparian vegetation.

2. The Corps, under the authority of section 7(a)(1) of the ESA, should implement recovery and recovery plan-based actions within and outside of traditional flood damage reduction projects. Such actions may include, but are not necessarily limited to restoring natural river function and floodplain development.

3. The Corps should cooperate with local levee maintenance districts, flood control agencies, and State and Federal resource agencies to develop an anticipatory erosion repair program that emphasizes the use of biotechnical techniques, and minimizes the use of rock rip rap to treat small erosion sites before they become critical.

4. The Corps should consider developing a programmatic PL84-99 biological assessment for future repairs, which would allow some use of bioengineering techniques in the repair designs.

5. The Corps should make more effective use of ecosystem restoration programs, such as those found in Sections 1135 and 206 of the respective Water Resource Developments Acts of 1986 and 1996. The section 1135 program seems especially applicable as the depressed baselines of the Sacramento River winter-run Chinook salmon, CV steelhead, and CV spring-run Chinook salmon are, to an appreciable extent, the result of the Corps' SRBPP program.

6. The Corps should incorporate the costs of conducting lengthy planning efforts, involved consultations, implementation of proven off-site conservation measures, and maintenance and monitoring requirements associated with riprapping into each project's cost-benefit analysis such that the economic benefits of set-back levees are more accurately expressed to the public and regulatory agencies. This includes a recognition of the economic value of salmonids as a commercial and sport fishing resource.

7. As recommended in the NMFS Proposed Recovery Plan for the Sacramento River winter-run Chinook Salmon (NMFS 1997), the Corps should preserve and restore riparian habitat and meander belts along the Delta with the following actions: (1) avoid any loss or additional fragmentation of riparian habitat in acreage, lineal coverage, or habitat value, and provide in-kind compensation when such losses are unavoidable (*i.e.*, create meander belts along the Sacramento River by levee set-backs), (2) assess riparian habitat along the Sacramento River from Keswick Dam to Chipps island and along Delta waterways within the rearing and migratory corridor of juvenile winter-run Chinook salmon, (3) develop and implement a Sacramento River and Delta Riparian Habitat Restoration and Management Plan (*i.e.*, restore marshlands within the Delta and Suisun Bay), and (4) amend the Sacramento River Flood Control and SRBPP to recognize and ensure the protection of riparian habitat values for fish and wildlife (*i.e.*, develop and implement alternative levee maintenance practices).

8. Section 404 authorities should be used more effectively to prevent the unauthorized application of riprap by private entities.

To be kept informed of actions minimizing or avoiding adverse effects, or benefiting listed or special status species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

X. REINITIATION OF CONSULTATION

This concludes formal consultation for the Steamboat Slough Levee Repair project in Sacramento, California. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological and conference opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Enclosure 2

<u>**Magnuson-Stevens Fishery Conservation and Management Act**</u>

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

This document represents the National Marine Fisheries Service's (NMFS) Essential Fish Habitat (EFH) consultation based on our review of information provided by the U.S. Army Corps of Engineers (Corps) on the proposed Steamboat Slough 18 Public Law (PL) 84-99 Levee Repairs, Sacramento County, California. The Magnuson-Stevens Fishery Conservation Act (MSA) as amended (U.S.C 180 et seq.) requires that EFH be identified and described in Federal fishery management plans. Federal action agencies must consult with NMFS on activities which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies. The geographic extent of freshwater EFH for Pacific salmon in the Sacramento River includes waters currently or historically accessible to salmon within the Sacramento River.

EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle.

The biological and conference opinion for the Steamboat Slough PL 84-99 Levee Repairs addresses Chinook salmon listed under the both the Endangered Species Act (ESA) and the MSA that potentially will be affected by the proposed action. These salmon include Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley spring-run Chinook salmon (*O. tshawytscha).* This EFH consultation will concentrate on Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) because they are covered under the MSA but not listed under the ESA.

Historically, Central Valley fall-run Chinook salmon generally spawned in the Central Valley and lower-foothill reaches up to an elevation of approximately 1,000 feet. Much of the historical fall-run spawning habitat was located below existing dam sites and the run therefore was not as severely affected by water projects as other runs in the Central Valley.

Although fall-run Chinook salmon abundance is relatively high, several factors continue to affect habitat conditions in the Sacramento River, including loss of fish to unscreened agricultural diversions, predation by warm-water fish species, lack of rearing habitat, regulated river flows, high water temperatures, and reversed flows in the Delta that draw juveniles into State and Federal water project pumps.

A. Life History and Habitat Requirements

Central Valley fall-run Chinook salmon enter the Sacramento River from July through December, and late fall-run enter between October and March. Fall-run Chinook salmon generally spawn from October through December, and late fall-run fish spawn from January to April. The physical characteristics of Chinook salmon spawning beds vary considerably. Chinook salmon will spawn in water that ranges from a few centimeters to several meters deep provided that the there is suitable sub-gravel flow (Healey 1991). Spawning typically occurs in gravel beds that are located in marginally swift riffles, runs and pool tails with water depths exceeding 1 foot and velocities ranging from 1 to 3.5 feet per second. Preferred spawning substrate is clean loose gravel ranging from 1 to 4 inches in diameter with less that 5 percent fines (Reiser and Bjornn 1979).

Fall-run Chinook salmon eggs incubate between October and March, and juvenile rearing and smolt emigration occur from January through June (Reynolds *et al.* 1993). Shortly after emergence, most fry disperse downstream towards the Sacramento-San Joaquin Delta and estuary while finding refuge in shallow waters with bank cover formed by tree roots, logs, and submerged or overhead vegetation (Kjelson *et al.* 1982). These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Smolts generally spend a very short time in the Delta and estuary before entry into the ocean.

II. PROPOSED ACTION

The Corps proposes to implement the Steamboat Slough Levee Repair Project to repair 17 sites in the Sacramento River Delta and one site in Steamboat Slough. A detailed description of the proposed action is provided in the *Description of the Proposed Action* section of the preceding biological and conference opinion (Enclosure 1).

III. EFFECTS OF THE PROJECT ACTION

The effects of the proposed action on Pacific Coast salmon EFH would be similar to those discussed in the *Effects of the Proposed Action* section of the preceding biological and conference opinion (Enclosure 1) for critical habitat of Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon. A summary of the effects of the proposed action on Central Valley fall-/late fall-run Chinook salmon is provided below.

Adverse effects to Chinook salmon habitat will result from construction related impacts, operations and maintenance impacts, and long-term impacts related to modification of aquatic and riparian habitat at the 18 project sites. Primary construction related impacts include riprapping approximately 7,500 linear feet of riverbank. Integrated conservation measures to minimize adverse effects of riprapping will be applied to all sites.

In-channel construction activities such as vegetation removal, grouting, and rock placement will cause increased levels of turbidity. Turbidity will be minimized by implementing the proposed conservation measures such as implementation of best management practices (BMPs) and adherence to Regional Board water quality standards. Fuel spills or use of toxic compounds during project construction could release toxic contaminants into the Sacramento River. Adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway because the prevention and contingency measures will require frequent equipment checks to prevent leaks, will keep stockpiled materials away from the water, and will require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak.

The effects of operation and maintenance (O&M) actions will be similar to construction impacts. O&M actions will not occur every year, and actions will be specific and localized in nature, O&M impacts will be smaller and shorter in duration.

IV. CONCLUSION

Upon review of the effects of Steamboat Slough Levee Repair Project, NMFS believes that the project will result in adverse effects to the EFH of Pacific salmon protected under the MSA.

V. EFH CONSERVATION RECOMMENDATIONS

Considering that the habitat requirements of fall-run within the action area are similar to the Federally listed species addressed in the preceding biological and conference opinion (Enclosure 1), NMFS recommends that Terms and Condition 1a and 1b; as well as all the Conservation Recommendations in the preceding biological and conference opinion prepared for the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead ESUs be adopted as EFH Conservation Recommendations.

Section 305(b)4(B) of the MSA requires the Corps to provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR 600.920[j]). In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

VI. STATUTORY REQUIREMENTS

Section 305(b)(4)(B) of the MSFCMA requires that the Federal agency provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the Federal agency for avoiding, minimizing, or mitigating the impact of the project on EFH [50 CFR 600.920(j)]. In the case of a response that is inconsistent with our recommendations, Reclamation must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

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